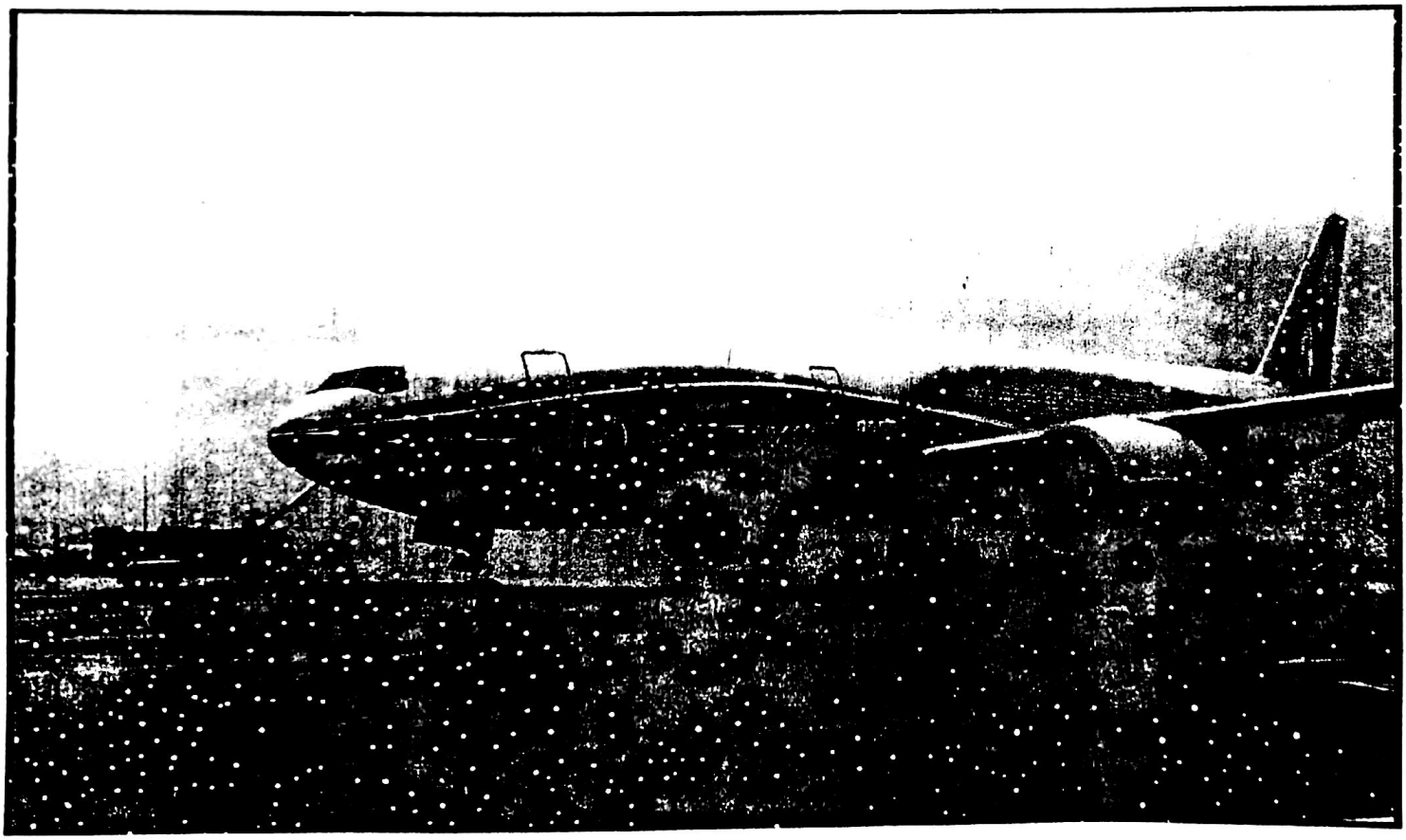
# ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR THE PROPOSED GREENFIELD INTERNATIONAL AIRPORT AT MOPA, GOA

## GOVERNMENT OF GOA



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*(QCI/NABET Accredited EIA Consultancy Organization*

# REPORT ON ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED GREEN FIELD INTERNATIONAL AIRPORT AT MOPA, GOA

| Rev. No | Date | Purpose | Prepared by | Reviewed by | Approved by |
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08/10/2014

# APPROVED TOR COMPLIANCE STATEMENT

| Sl. No. | Statement | Status |
|---|---|---|
| 1 | Describe the project site, geology, topography, climate, transport and connectivity, demographic aspects, socio cultural and economic aspects, villages, settlements and meteorological data. | Details of project site in terms of various environmental features are described in various sections of Chapter 2. |
| 2 | Details of master plan and integration of the airport in the regional plan. | A comprehensive master plan prepared by M/s Lewis Berger including the design of layout and other details is attached separately. |
| 3 | Examine details of land use around 10 km radius of the project site. Analysis should be made based on latest satellite imagery for land use with raw images. | Land use in terms of built up land, agriculture land, wastelands, water bodies and other forms is mapped using satellite imagery and the thematic map is attached as Annexure IX. |
| 4 | Examine the details of the impact on the nearby pond due to the project. | From project site, there exits a pond in eastern direction at a distance of about 5 kms. However, before the pond Kalna river is flowing. In view of the same, the drainage from the airport site joins Kalna river and there will be no impact on the pond. This is depicted in thematic maps and are attached in annexure IX and X. |
| 5 | Environmental data to be considered in relation to the airport development would be a) land, b) groundwater, c) surface water, d) air, e) biodiversity, f) noise and vibrations, g) socioeconomic and health | All mentioned parameters are considered in EIA Study |
| 6 | Examine baseline environmental quality along with projected incremental load due to the project shall be studied. | Baseline data of various components of environment is described in various sections of chapter 4.<br><br>The impact of incremental load on various components of environment is assessed and evaluated in terms of significance value and is given in various sections of chapter 5. |
| 7 | Examine the details of ambient air quality | Ambient air quality in terms of various parameters is described in **section 4.1.2** of **chapter 4.** |
| 8 | Examine the impact of airport location on the nearest settlements. | The impact of airport location on nearest settlements in terms of noise during take off and landing is assessed and evaluated. The same is given in **section 5.3.4** of **chapter 5.** In addition, the general impacts on socioeconomic environment due to development of new airport is given in **section 5.3.6 of chapter 5.** |
| 9 | Examine and submit contour map showing the slopes, drainage pattern of the site and surrounding area of the site. Examine in detail the diversion of surface | A comprehensive assessment on run-off, drainage in 10 kms buffer zone and within the proposed site is estimated and is given in **section 5.3.3 of chapter 5.** |

| | | |
|---|---|---|
| | drain system because of low lying area. | The same is assessed and evaluated. The drainage map is superimposed on contour map and is shown in **figure 5.1** of **chapter 5.** |
| 10 | Examine and submit levels, quantity required for filling, source of filling material and transportation details etc. | The proposed airport is predominantly a tabletop plateau and requires no cutting and filling. |
| 11 | Examine and submit details of geo-technical studies | Thematic map indicating geological features is given in annexure XI.<br>Quality soil in terms of various parameter are given in Incorporated in Chapter 4 of section 4.4.1 |
| 12 | Examine road/rail connectivity to the project site and<br>Impact on the traffic due to the proposed project. A detailed traffic and transportation study should be made for existing and projected passenger and cargo traffic. | Thematic map indicating transportation features in terms of road and rail in buffer zone and its connectivity to the project site is attached as annexure XIV and annexure XV.<br><br>Traffic forecast for existing and projected passenger and cargo traffic has been done in **section 2.2** of **chapter 2.** Impact due to traffic is also assessed in **section 5.3.4 of chapter 5.** |
| 13 | Examine the details of parking requirement for various type of vehicles and circulation plan. | Details of parking requirement have been given in general aviation in **section 2.4.1** of **Chapter 2.** Area has been depicted in airport layout plan that is attached as annexure VIII. |
| 14 | Examine the details of construction material and its transportation. | Details of construction material have been given in **section 10.1.5** of **chapter 10.** |
| 15 | Examine the details of probability of flooding of the agricuitural land and other area due to the proposed development/construction of the airport. | Details have been provided in section no. **section 5.3.3** of **chapter 5.** |
| 16 | Examine the details of afforestation measures indicating land and financial outlay. Landscape plan, green belts and open spaces may be described. A thick green belt should be planned all around the nearest settlement to mitigate noise and vibrations. The identification of species/ plants should be made based on the botanical studies. | Details of plantation to be done at various locations within the airport complex have been identified and are incorporated in **section 10.4** and **section 10.5** of **Chapter 10.** |
| 17 | Examine and submit the details of noise modeling studies and mitigative measures. | Details of noise modeling studies is provided in section 5.3.4 of Chapter 5. |
| 18 | Examine soil characteristics and depth of ground water table for rainwater harvesting before and after the rainy season. | Depth of ground water table is given in annexure IV. Soil characteristic is given in **Table No. 4.9** in **chapter 4.**<br>Rainwater harvesting is described in **section 5.3.2 and 5.3.3 of chapter 5** |

| | | |
|---|---|---|
| 19 | Examine the details of water requirement, use of treated waste water and prepare a water balance chart. Source of water. | Details of water requirement and water balance are given in **section 2.3.4** of chapter 2.<br><br>Wastewater generation and reuse is given in **section 2.3.5** of chapter 2. |
| 20 | Rain water harvesting proposals should be made with due safeguards for ground water quality. Maximize recycling of water and utilization of rain water. | Details of Rain water harvesting pit is given in annexure II and annexure III |
| 21 | Examine details of solid waste generation treatment and its disposal. | Solid waste collected during operation phase will be disposed in disposal facility owned by Government of Goa, incorporated in section 5.3.3 of chapter 5. |
| 22 | Examine the details of fuel storage. | Fuel storage details are incorporated in section 2.5 of chapter 2. |
| 23 | Examine details of the energy requirement and conservation measures using alternate source of energy. | Energy requirement and conservation details are incorporated in section 2.3.7 of chapter 2. |
| 24 | Seismic nature of the area shall be taken into consideration in the design. | The proposed site falls in Seismic Zone III and is considered in developing master plan |
| 25 | The terminal building should carefully incorporate the features of local architecture in and around the area as well as take special measures top highlight the Indian antiquity through a museum like corner depicting the same. | Master plan is developed considering local architectural features and is attached separately. |
| 26 | Identify, predict and assess the environmental and sociological impacts on account of the project. | The environmental and sociological impact assessment is done in section 5.3.6 of chapter 5. |
| 27 | Examine separately the details for construction and operation phases both for Environmental Management Plan and Environmental Monitoring plan with cost and parameters. | Environmental management plan is given in chapter 10 and environmental monitoring plan is given in chapter 6. |
| 28 | Submit details of a comprehensive Disaster Management Plan including emergency evacuation during natural and man-made disaster. | Comprehensive Disaster Management Plan is given in Chapter 7 |
| 29 | Submit details of Corporate Social Responsibilities (CSR). | Presently, Govt. of Goa is the owner of the proposed Greenfield international Airport at Mopa, Goa. Under such circumstances Govt. of Goa cannot separately formulate the CSR. Accordingly communication has sent to MoEF to waive off the CSR point of point no. xxix in the approved TOR. |
| 30 | Details of economics of agricultural land loss in longer period for the proposed development. | The land required has been acquired based on approved compensation as per Govt. of Goa |

## CONTENTS

**LIST OF ANNEXURES:**

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# EXECUTIVE SUMMARY

## 1.0 Executive Summary

The Executive Summary covers the following topics in brief:

1. Project Description
2. Description of Environment
3. Anticipated Environmental Impacts and Mitigation measures
4. Environmental Monitoring Program
5. Environment Management Plan
6. Additional studies
7 Project Benefits

## 1.1 Project Description

The Government of Goa has undertaken the development of a new Greenfield Airport for Goa, near the Village of Mopa (N 15°44'30", E 73°52'00"). The Village of Mopa is located in North Goa near the Maharashtra border, approximately 35 kilometers north of the Panaji, the Goa State Capital. The new Greenfield Airport at Mopa will be an international Airport serving both the tourism and business markets and keeping pace with the burgeoning air travel segment in India. The proposed airport will attract 2.8 million international and domestic passengers in phase I (2020) and 7.3 million passengers in phase II development to meet a forecast demand of rise in air travel.

The components in Phase I of proposed Mopa Airport shall include one runway, with half parallel taxiway, three runway exits and in Phase II includes one runway, with full parallel taxiway. seven runway exits including four rapid exits. The other facilities includes Terminal building, Security area and control points, GSE storage, parking, technical area, cargo, maintenance, general and business aviation areas, road network , rail connectivity and airport city (with a hotel, offices, business centre, golf course, employees accommodation etc.) The estimated cost of the project in Phase I is Rs 8748 Crores. An area of 2271 acres is envisaged for project development.

**Proposed Configuration of MOPA airport**

A master Plan has been made prepared for phase-wise development of the airport over a period of 30 years by Ammann & Whitney USA ,The Louis Berger Group, Inc. Planning phases have been established as 2015-2020, 2021-2025, 2026-2035 and 2036 to 2045. Facility requirements within the phases are demand driven, based on forecasts of aviation activity and level of service provided.

**In phase I development,** the airport is initially designed with a level of service adequate to satisfy the demand of approximately 4.4 million passengers by providing Mopa International Airport with one runway and one processing terminal building with one associated pier.

**Runway**
In the opening phase, the airfield consists of one single runway with 095° northeast – 275° southwest orientations at the north of the site (designation 09/27) with a takeoff available distance of 3,750 meters and 60 meters of runway width to accommodate the super-jumbo A380 aircraft.

**NAVAID**

The runway will be equipped with both elevated and inset lights for at-all-time operations consisting of a CAT I approach system before both runway thresholds which comprises a row of lights, along the extension of the runway axis, to a distance of 900 m.

**Runway Exits**

In order to optimize the runway occupancy time at this stage to an efficient level of 50 seconds, approximately, for large and heavy aircraft the runway will be provided with two rapid exits for each approach configuration at an angle of 30° located at 1800 and 2400 from each runway threshold. Also, two perpendicular runway exits at each runway end will be provided with a minimum distance between them of 97.5 meters according to taxiway minimum separation distances.

**Taxiways**

In phase I, the runway exits connect to a full parallel taxiway of 3750 meters long and 25 meters wide plus paved shoulders of 17.5 meters wide at each side of the taxiway.

**Commercial Apron**

In Phase I, the main commercial aircraft parking apron will have a paved surface area of approximately 114,000 $m^2$. In phase II development, the main commercial aircraft parking apron will have a paved surface area of approximately 159,600 $m^2$

**Cargo Apron**

The cargo apron is located at about 500 meters left of the terminal building and connected by a taxiway of 25 m wide plus shoulders of 17.5 m wide. The cargo apron is designed to accommodate up to 1 wide-body freighters at the same time with a total area of 5,250 $m^2$.

**Aircraft Maintenance Area**

The area required for these activities, including apron and hangars, is expected to be 15,300 $m^2$. The aircraft maintenance facilities are estimated to provide space for 1 hangar.

Details of other phases are described in chapter 2 of this report.

## 1.2 Description of Environment

In order to minimize the impact of the project on the environment, due attention is given for implementing effective pollution control measures.

**Air Environment:**

| S.No | Environmental parameter | Base line value in ppm | Standard in ppm |
|---|---|---|---|
| 1 | SPM | 29-53 | 200 |
| 2 | RPM | 14-28 | 100 |
| 3 | $SO_2$ | 7.6-18.5 | 80 |
| 4 | $NO_X$ | 9-21.8 | 80 |
| 5 | Bcth CO and HC were found <100 $\mu g/m^3$ | | |

**Water Environment:**

Ground water quality:

| Sr. No. | Parameter | Unit | Dargal (Dug well) | Patradevi (Dug well) | Mopa Village (Dug well) | Pernem (Dug well) | Permissible limit IS:10500: 1991 |
|---|---|---|---|---|---|---|---|
| 1 | pH | - | 7.10 | 6.64 | 7.70 | 6.62 | 6.5 – 8.5 |
| 2 | Conductivity | µmhos/cm | 150 | 190 | 260 | 190 | - |
| 3 | Turbidity | NTU | 1.0 | 2.0 | 2.0 | 1.0 | 10 |
| 4 | Total Dissolved Solids | mg/l | 102 | 128 | 182 | 132 | 2000 |

Surface Water Quality:

| Sr. No. | Parameters | Unit | Chapora River | Tiraikol River | Nala Near Mopa Viliage |
|---|---|---|---|---|---|
| 1 | pH | - | 7.25 | 7.44 | 6.92 |
| 2 | Conductivity | µmhos/cm | 13356 | 15300 | 340 |
| 3 | Colour | Hazen Unit | Colourless | Colourless | Colourless |
| 4 | Odour | - | Unobjectionable | Unobjectionable | Unobjectionable |
| 5 | Turbidity | NTU | 4 | 6 | 3 |
| 6 | Total Dissolved Solids | mg/l | 8690 | 9980 | 258 |

**Noise Environment:**

The noise levels in all the locations monitored are in between 43.7- 53.8 dB (A) in the day time and in between 39.5- 44 dB (A) in the night time. They are within the residential area noise level limit of 55 and 45 dB (A) respectively.

**Soil Environment:**

| S.No | Parameters | Sinechaadvin | Nagzor | Pernem | Katwal | Mopa |
|---|---|---|---|---|---|---|
| 1 | pH (20% slurry) | 7.10 | 7.12 | 6.90 | 8.25 | 7.32 |
| 2 | Conductivity (20% slurry), µmhos/cm | 158 | 182 | 169 | 172 | 185 |
| 3 | Texture | Sandy | Sandy | Sandy | Sandy | Sandy |
| 4 | Bulk Density; g/cm$^3$ | 1.69 | 1.52 | 1.64 | 1.51 | 1.63 |
| 5 | Infiltration, Cm/hr | 6.36 | 7.15 | 6.75 | 8.56 | 7.35 |
| 6 | Water Capacity Hoiding , | 28.50 | 25.75 | 29.50 | 24.30 | 26.74 |

## 1.3 Anticipated Environmental Impacts and Mitigation measures

Summary of potential impacts identification and its evaluation of the proposed Airport facilities are as follows in table 1.5.

**Table 1.5 a: Impact Identification**

| Activities | Ambient air quality | Ground / surface water (quantity / quality) | Ambient noise | Land (land use, topography & drainage, soil) | Flora | Fauna | Livelihood & occupation | Infrastructure |
|---|---|---|---|---|---|---|---|---|
| **CONSTRUCTION** | | | | | | | | |
| Civil and mechanical works | × | × | × | × | × | × | × | × |
| Movement of vehicles | × | | × | | | × | | × |
| Waste water generation, handling and disposal | | × | | × | | | | × |
| Solid waste generation, handling and disposal | | | | × | | | | × |
| **OPERATION** | | | | | | | | |
| movement of Aircrafts during landing and takeoff | × | | × | | | | | |
| Storage of Fuel | × | | | | | | | |
| Cleaning & maintenance | | × | | × | | | | |
| Operation of emergency power generation facility | × | | × | | | | | |
| Waste water generation, handling and dispcsal | | × | | × | | | | |
| Solid waste generation, handling and disposal | | | | × | | | | |
| Movement of vehicles | × | | × | | | × | | × |

**Table 1.5 b: Impact evaluation and its significance value**

| Component | Impact | | Impact | |
|---|---|---|---|---|
| Air | Marginal addition of Dust pollution, Vehicle exhausts (CO, HC, NOX) due to movement of vehicles. | Low | Increase in air pollution such as SPM, RPM, SO2, NOX, HC and CO. Due to aircraft movement, HC and CO shall be 0.64 g/s and 14.86 g/s for a period of 19 minutes and 26 minutes respectively & 236 g/s of $NO_X$ for a period of 42 seconds only, which are insignificant | Medium |
| Water | Consumption of water for construction purposes, drinking, sanitation etc., | Medium | 1.2 MLD is the raw water is required for passengers and staff consumption | Medium |
| | Waste water generation | Low | Treated 0.8 MLD of sanitary waste water in phase I to be used in horticulture. | Low |
| Noise | Increase in noise levels due to movement of construction traffic and operation of construction equipment. | Low | Increase in ambient noise levels near runway during landing and takeoff of aircraft. The maximum noise emission 90 dB will be near runway. | Medium |
| Biological | The area acquired for proposed airport have only few trees but mainly bushes. These will be cleared during site preparation. Open pipeline trench and un-barricaded waste/waste water pits may lead to injury of animals which fall in them. | Medium | The movement of vehicles may result in road kills of animals. | Medium |
| Land | Land use and topography | Low | Generation of solid waste (soil quality) | Low |
| | Soil quality | Low | | |
| Socio-economic | Direct / Indirect Employment generation. | Low | Positive impact on socio-economic development. Increase in revenue due to increase in tourism and increase in secondary jobs. | Low |

## 1.4 Environmental Monitoring Program

The proposed environmental monitoring program is mentioned below Table 1.6.

**Table 1.6 Proposed environmental monitoring program**

| CONSTRUCTION PHASE | | | | |
|---|---|---|---|---|
| **S. No.** | **Potential impact** | **Action to be Followed** | **Parameters for Monitoring** | **Frequency of Monitoring** |
| 1 | Air Emissions | All equipment are operated within specified design parameters. | Random checks of equipment logs/ manuals | Periodic |
| | | Vehicle trips to be minimized to the extent possible. | Vehicle logs | Periodic during site clearance & construction activities |
| | | Any dry, dusty materials stored in sealed containers or prevented from blowing. | Absence of stockpiles or open containers of dusty materials. | Periodic during construction activities |
| | | Compaction of soil during various construction activities | Construction logs | Periodic during construction activities |
| 2 | Noise | Night working is to be minimized. | Working hour records | Daily records |
| | | Generation of vehicular noise | Maintenance of records of vehicles | Daily records |
| | | Acoustic mufflers / enclosures to be provided in large engines | Mufflers / enclosures in place. | Prior to use of equipment. |
| | | Vehicle trips to be minimized to the extent possible | Vehicle logs | Periodic during construction activities |
| 3 | Soil Erosion | Protect topsoil stockpile wherever possible. | Effective cover in place. | Periodic during construction activities |
| 4 | Health | Employees and migrant labour health check ups | All relevant parameters including audiomerty | Regular check ups |
| 5 | Construction camps | Away from settlements and ensure disciplinary procedures. | Regular monitoring | Pre-construction |

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| | | Avoid use of public infrastructural facilities such as power, gas and water and maintain hygienic conditions | | |
| 6 | Waste Management | Identification & characterization of every waste arising from proposed activities as per prevalent waste management plan and which also identifies the procedures for collection, handling & disposal of each waste arising. | Comprehensive Waste Management Plan in place and available for inspection on-site. Compliance with Hazardous Wastes (Management and Handling Rules), 2008 | Periodic check during construction activities |
| 7 | Fuel and oil leaks | Use designated fuel storage methods and ensure that oil spill response plan is in place | Visual inspection and monitoring of soil and ground water quality | Throughout construction period |
| 8 | Non-routine events and accidental releases | Plan to be drawn up, considering likely emergencies and steps required to prevent/limit Consequences. | Mock drills and records of the same | Periodic during construction activities |
| 9 | Public and animal safety | Erection of warning barriers | Routine monitoring and checks | Throughout construction period |
| 10 | Water and waste water | Take care in disposal of Waste water generated such that soil and groundwater resources are protected. | Discharge norms for effluents as given in permits | Periodic during construction activities |
| **OPERATION PHASE** | | | | |
| 1 | Air Emissions | Stack emissions to be optimized and Monitored. | Gaseous emissions ($SO_2$, HC, CO, NOx). | Periodic during operation phase |
| | | Cold venting any from storage tanks | Quantity and cold venting if any. | Continuous |
| | | Ambient air quality within the premises of the proposed unit and nearby habitations to be monitored. Exhaust from vehicles to be minimized by use of fuel | SPM, RSPM, $SO_2$, NOx, CO, HC<br><br>Vehicle logs to be maintained | As per CPCB/ SPCB requirement or on monthly basis whichever is earlier |

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|---|---|---|---|---|
| | | efficient vehicles and well maintained vehicles having PUC certificate. | | |
| | | Measuring onsite data of Meteorology | Wind speed, direction, temp., relative humidity and rainfall. | Periodic during operation phase |
| | | Vehicle trips to be minimized to the extent Possible. | Vehicle logs | Daily records |
| 2 | Indoor air contamination | Pollutants such as CO, CO2 and VOCs to be reduced by providing adequate ventilation. | Monitoring of indoor air pollutants such as CO, CO2 and VOCs. | As per CPCB / MPSPCB requirement |
| 3 | Noise | Noise generated from operation of DG set to be optimized and monitored. DG sets are to be provided at basement with acoustic enclosures | Spot Noise Level recording; Leq (night), Leq (day), Leq (dn) | Periodic during operation phase |
| | | Generation of vehicular noise | Maintain records of vehicles | Periodic during operation phase |
| 4 | Water Quality and Water Levels | Monitoring groundwater quality and levels around Airport premises | Comprehensive monitoring as per IS 10500 | Once in a season |
| 5 | Wastewater Discharge | No untreated discharge to be made to surface water, groundwater or soil. The cleaning water shall be disposed in nearby ETP. | No discharge hoses in vicinity of water courses. | Periodic during operation phase |
| | | Take care in disposal of Wastewater generated such that soil and Groundwater resources are protected. | Discharge norms for effluents as per ETP norms | Periodic during operation phase |
| 6 | Maintenance of flora and fauna | Vegetation and greenbelt / green cover development. | No. of plants species | Periodic during operation phase |
| 7 | Health | Employees and migrant labor health check ups. | All relevant parameters including audiometry | Regular check ups |
| 8 | Energy Usage | Energy usage power generation, air conditioning and other activities to be minimized. Conduct annual energy audit for the terminals | Energy audit report | Annual audits and periodic checks during operational phase |

## 1.5 Environmental Management Plan

The EMP in the design stage endeavors to mitigate the problems related to health, safety and environment at the process technology selection stage and at the design stage. The Airport facilities have been designed taking into account all applicable standards/ norms both for regulatory and safety purpose. A summary of impacts. mitigation measures and proper environmental management plan is given in Table 1.7.

**Table 1.7 Environmental Management Plan**

| Sl. No | Environmental Component | Activity/Aspect | Impacts | Mitigation Measures | Element of Environmental Management Plan |
|---|---|---|---|---|---|
| 1 | Air Environment | • Foundation work<br>• Digging, leveling work<br>• Structural works | Very less conventional pollutants will be released during this phase due to construction works, vehicle exhausts which will not cross the specified limits because low value of background levels | • Dust pollution will be suppressed using water sprinklers<br>• Periodic maintenance of machinery, heavy vehicles | Regular monitoring of levels of conventional pollutants as per MPPCB guidelines |
| 2 | Water Environment | Maintenance of drainage and water supply network for Sanitation and waste water generation | Limited impact on surrounding water bodies/aquatic ecosystems/ground water due to soil erosion, leaching, waste water generation | • Water requirement through existing raw water source<br>• Proper sanitation<br>• Waste water treatment through existing treatment plant | • Provision for appropriate sanitary facility for construction workers |
| 3 | Land Environment | Land use change due to drilling, excavating | • Land pollution of small magnitude due to solid waste generation<br>• Overburden and construction waste will also be | • Management of solid waste<br>• Management of excavated solid and construction waste | • Composting bio-degradable waste and disposal of non bio-degradable waste in land fills<br>• Construction waste will be used for back filling |

| | | | | | |
|---|---|---|---|---|---|
| | | | produced | | |
| 4 | Noise Environment | Noise from construction, heavy vehicle movements | Noise level will be more but within the permissible limits (45-75 dB(A)) | • Noise protection measures<br>• Using ear muffs for workers while construction | • Rules & regulations of Noise Standards will be followed<br>• Greenbelt development for attenuating the noise levels |
| 5 | Socio-economic Environment | Rehabilitation & resettlement | More benefits to the local people | • Employment opportunities to local skilled and unskilled people<br>• Development of infrastructure, communications facility, drinking water supply, health etc.<br>• Social and cultural development | • Facilitation of hospital, school, club, stadium etc.<br>• Regular health camp surrounding the plant<br>• Implementation of CSR Policy |
| 6 | Biological Environment | Land use change | • Impact on flora and fauna will be minimal<br>• Less impact on marine ecosystem | • Creation of landscape with plantation<br>• Conservation of biodiversity | • Biological diversity Act and MoEF guidelines for conservation of species will be followed<br>• Greenbelt development with more fruit bearing trees, avenue plantation etc. will be made |
| **OPERATION PHASE** | | | | | |
| 1 | Air Environment | • Air emissions (Conventional)<br>• Movement of vehicles | • Insignificant impact as conventional pollutants emission will be within the permissible limits. | •Compliance to standards<br>•Continuous monitoring | • Control air emissions at source<br>• Treatment to reduce air emissions<br>• Regular monitoring of the levels of conventional |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | pollutants as per MPPCB requirements<br>• Regular maintenance of vehicles and equipment |
| 2 | Water Environment | Operation of new process units and utilities | Limited impact on surrounding water bodies/aquatic ecosystems/ground water | • Proper management of active and domestic waste water<br>• Proper design of condenser Cooling systems<br>• Rain water harvesting | • Liquid effluents discharge will be much below discharge limits of CPCB norms<br>• Treatment of domestic waste and reuse of water for irrigation of plantation/green belt<br>• Regular monitoring of the levels of conventional pollutants as per MPPCB norms<br>• Implementation of rain water harvesting |
| 3 | Land Environment | Disposal of solid waste | Land pollution of small magnitude due to solid waste generation | • Management of plant and domestic solid waste<br>• Development of green belt | • Treatment and disposal of solid waste as per CPCB/MPPCB norms<br>• Disposal of non degradable waste in proper land fills<br>• Development of green belt in the plant area |
| 4 | Noise Environment | Noise from plants, DG sets etc. | Insignificant noise levels in public domain | • Control of noise levels within permissible limits<br>• Development of barriers to control noise | • Noise levels due to plant activities will be controlled within permissible limits<br>• Noise |

| | | | | | |
|---|---|---|---|---|---|
| | | | | • Follow occupational health and safety measures | generating units will be housed in acoustic enclosures<br>• Development of green belt will act as a barrier<br>• Personal Protective Equipment (PPE) will be provided to workers wherever required<br>• Noise standards of CPCB will be adhered with |
| 5 | Socio-economic Environment | Rehabilitation & resettlement | More benefits to the local people | • Employment generation<br>• Awareness camps<br>• Medical camps | • Implementation of social welfare schemes for the local people<br>• Awareness on Social benefits among local people through seminars, workshops, exhibitions<br>• Preference will be given to local people<br>• Ensure participation of local people in cultural events to create social harmony and goodwill |

| | | | | | |
|---|---|---|---|---|---|
| 6 | Biological Environment | Discharge/ releases to air & water. | Impact on terrestrial flora and fauna | • Adequate protection measures should be ensured in design for conservation of flora and fauna | • Development of green belt with indigenous tree species<br>• Control of eutrophication by treatment and reuse of waste water<br>• Regular monitoring of biodiversity and listing the same<br>• The plant design will envisage the conservation of flora & fauna. |
| 7 | Health, Safety & Environment | Conventional emissions | Health effects of pollutants | • Occupational health & safety<br>• Safety in plant design<br>• Monitoring & compliance to OSHA standards | • Safety in plant design as per OSHA norms<br>• Regular monitoring of the pollutant levels in different components of surrounding environment<br>• Regular health check-up of the workers<br>• Hazard analysis and safety measures in work place to reduce the undue risk to employees, members of public & environment as per OSHA requirements<br>• EMP implementation and environmental monitoring programme to |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | evaluate the effectiveness of environmental management systems. |

## 1.6 Additional Studies

### 1.6.1 Disaster Management Plan

This chapter outlines the role and responsibility (and their initial actions) of identified personnel in case of emergency break out in Airport.

## 1.7 Project Benefits

The significant positive impact on employment and occupation is envisaged on account of:

- Generate direct and indirect employment;
- Improve the social and economic environment in the vicinity and meets the fuel needs of the state;
- Better economic status of the community due to better earnings;
- Higher inputs towards infrastructural facilities ;

# CHAPTER 1

# INTRODUCTION

## 1.0 INTRODUCTION

India is a fast-growing aviation market and it is expected to be among the four to five biggest aviation markets by 2020 and third in terms of domestic market after US and China. The major driving forces behind this rapid growth are Deregulation of the aviation sector, Positive macro-economic trends, Tourism, and Emergence of low cost and premium service carriers.

Goa, well known for its beaches and places of worship in India, promotes tourism as its prime industry. As tourism continues to flourish, the demands of the existing Dabolim Airport in Goa are increasing at an unprecedented rate. Capacity constraints and military restrictions are putting an ever increasing strain on the existing facilities for aircraft and passengers alike.

In view of the same, the Government of Goa has undertaken the development of a new Greenfield Airport for Goa, near the Village of Mopa. The Village of Mopa is located in North Goa near the Maharashtra border, approximately 35 kilometres north of the Panaji, the Goa State Capital. The project is being developed by the Government of Goa under a public-private partner-ship (PPP) model in accordance with the Greenfield Airports Policy of the Ministry of Civil Aviation.

The Government of India has formalized its Policy on Greenfield Airports as of April 2008. Under that policy and the rules preceding its adoption, the Government of Goa had applied for and been granted 'in-principle' approval in March 2000. Consistent with the Policy on Greenfield Airports, project development is continuing under the guidance of an airport Steering Committee chaired by the Chief Minister of the Government of Goa.

Ministry of Environment and Forest & Climate change (MoEF & CC) has approved terms of reference (TOR) for EIA study wide letter no. 10-29/2011.IA.III dated 11-12$^{th}$ May 2011. Accordingly Govt. of Goa has entrusted the task of carrying out EIA to Engineers India Limited (EIL) as per approved TOR.

## 1.1 PURPOSE OF THE PROJECT

Commercial air service to Goa is currently concentrated in the Goa International Airport at Dabolim, located in South Goa. This airport handled just over 3 million annual passengers during the fiscal year (2010-11) and is the 9th busiest airport in India. Airport facilities are shared with Navy which has resulted in important restrictions on commercial operations including reserved hours of operation and priority for operations in addition to the restricted hours.

The proposed airport will attract 2.8 million international and domestic passengers in phase I (2020) and 7.3 million passengers in phase II development. This will subsequently generate employment opputunities for both airport requirements and additional commercial requirements. This will also lead to development of ancillary inducties namely Hotels, Tourism, automobile repair shops etc. The addition of air cargo operations is expected to shift the current ground-based movements in Goa and attract air operations currently conducted outside the area.

## 1.2 BRIEF DESCRIPTION OF PROJECT

Development of the Airport site will further meet the goals of the Regional Plan for Goa 2021 which sets out the area as a hub for economic development, and benefit the local area including nearby towns and cities in the neighboring states of Maharashtra and Karnataka.

The summary of the proposed Airport site is given in Table 1.1.

**Table – 1.1 Project Site Description**

| S. No | Particulars | Details |
|---|---|---|
| 1 | Latitude | N 15$^0$44'30" |
| 2 | Longitude | E 73$^0$52'00" |
| 3 | Elevation | 140 to 170 m above MSL |
| 4 | Revenue Village | Mopa |
| 5 | Tehsil | Pernem |
| 6 | District and state | North Goa, Goa |
| 7 | Nearest Highway | NH-17 & NH-4 |
| 8 | Total area | 2271 Acres |
| 9 | Nature of Soil | Laterite / Reddish brown sandy soil |
| 10 | Nearest Railway Station | Pernem railway station at approx. 11 km |
| 11 | Nearest Water bodies | 1. Kalna River (also called Chandel River) which is a tributary of Charpora River<br>2. Tillari Irrigation Canal |
| 12 | Seismic Zone | Zone – III (as per IS-1893, Part III :2002) |
| 13 | Inter-state boundaries | State Maharashtra is located about 2 Km from the project location |

## 1.3 SCOPE OF THE EIA STUDY

TOR for the proposed Greenfield International Airport was approved in the 100th Meeting of EAC held on 11$^{th}$ – 12$^{th}$ May 2011 in New Delhi. After this certain changes has been made and sorted for revised TOR. The changes were,

- The revised project boundary is within the latitude and longitude submitted earlier.
- The land area required for project development has decreased from 4500 acres envisaged earlier to 2271 acres present.
- 14 houses need to be displaced and R&R Policy of Govt of Goa to be followed.
- Annual traffic forecast has been updated.

Due to the above changes revised TOR had been issued and the same is attached as Annexure –I.

## 1.4 FRAME WORK OF ASSESSMENT

The Environmental Impact Assessment (EIA) report shall cover the environmental components such as air, water, land, noise, biological and socio-economic aspects within a radius of 10 km from the project location. Major impact on account of development of the proposed green field airport shall be due to the following:

- Location of airport
- Construction activities
- Airport operation, including air traffic and associated noise & emissions, and
- Cargo handling & storage, and land transport

Therefore, Chronological frame work for assessment of impacts has been made in three discrete phases of the project as:

- Construction phase
- Operation Phase

## 1.5 COVERAGE OF ENVIRONMENTAL IMPACT ASSESSMENT STUDY

According to EIA Notification dated 14th September 2006, and amended in 2009 and past experience of EIL and as per provisions of section of Environment Act a corridor encompassing of area within 10km radius of proposed project location is considered as spatial frame for the impact assessment.

the coverage of EIA report is outlined in the following sections.

### 1.5.1 PROJECT SETTING, DESCRIPTION AND ANALYSIS OF SITE AND TECHNOLOGY

The proposed project site details, main Airport facilities have been defined and the description also gives details of wastes (gaseous / liquid / solid / noise) generation sources from the proposed Airport.

### 1.5.2 IDENTIFICATION OF IMPACTS

This includes impact identification of each of the environmental parameters. In order to identify the impacts comprehensively, all the activities associated with the proposed airport facilities are analysed during the construction as well as operational phase of the project.

### 1.5.3 BASELINE DATA COLLECTION

Once the affected environmental parameters are identified, various environmental parameters of concern are identified to establish its background quality. For this project, baseline data was provided by Client which was collected by M/s EMTRC Lab, EMTRC Consultants private limited, Ghaziabad (UP). This is an NABL Accredited Lab (ISO/IEC:17025), ISO:9001, OHSAS:18001. The environmental data was collected for the period of October 2011 to December 2011 by M/s EMTRC Lab,. Data thus collected has been utilized here to establish baseline quality of various environmental parameters.

### 1.5.4 ENVIRONMENTAL IMPACT PREDICTION & EVALUATION

In this part of the report the sources of emissions (Gaseous, Liquid, Solid, Noise) due to the proposed activities will be identified and based on their emission loads their impacts are to

be predicted. Such predictions are then superimposed on baseline quality (wherever there is an additional impact) and quantitative/qualitative assessments have been made for the impacts.

### 1.5.5 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

In order to mitigate or minimise the negative impacts of the proposed project, an effective EMP is called for. Therefore, in the final part of the report the planning and implementation of various pollution abatement strategies including the proposed monitoring/surveillance network has been described.

## 1.6 ADDITIONAL STUDIES

In addition to the above Disaster Management plan was carried out by EIL and is presented in chapter 7 of the EIA Report.

# CHAPTER 2

# PROJECT DESCRIPTION

## 2.1 DESCRIPTION OF THE PROPOSED SITE

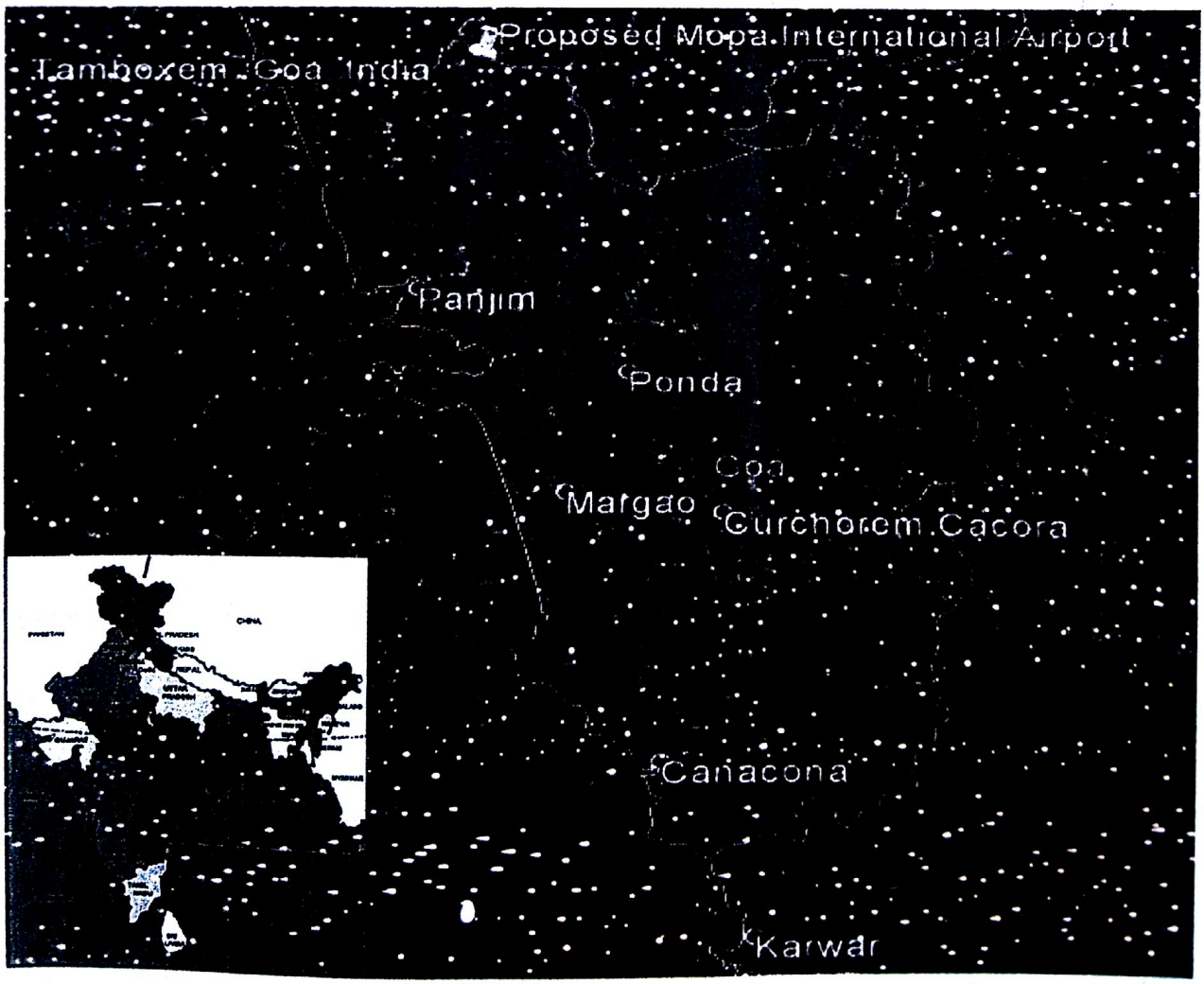
The project site (N 15$^0$44'30", E 73$^0$52'00") is located near the Village of Mopa, Pernem Taluka in northern-most Goa along the Maharashtra border. The site is comprised of property acquired from six villages viz., Varconda, Casarvornem, Amberem, Uguem, Mopa and Chandel. Location of the project site is shown in figure 2.1 and annexure XIII.

The airport development site is accessed from National Highway 17 which runs north-south through Goa and connects along the coastline to Panvel in Maharashtra to the north and in the south through Karnataka to Edappalli in Kerala. The proposed approach road to the new airport begins from NH-17 at Dhargal village and passes through land in the villages of Ozorim, Varconda and Casarvornem. The Konkan Railway Line runs virtually parallel to NH 17 near the airport and also connects Goa to the other states of India. The Regional Plan for Goa also envisions improvements in the railway network including double tracking and connection to the proposed airport.

An area of 2271 acres is envisaged for project development. The expected cost of the project in phase 1 excluding airport city is INR 8748 million.

The components in phase I includes one runway, with half parallel taxiway, three runway exits and in phase II includes one runway, with full parallel taxiway, seven runway exits including four rapid exits and other facilities discussed in detail in later sections.

**Figure 2.1: Location Map of Project Site**



The land originally designated by the Government of Goa for development of the new Greenfield airport is predominantly a tabletop plateau area surrounded by steep slopes that act as natural drains. The approximate ground level of the plateau areas ranges between 140 and 170 meters (m) above mean sea level (MSL) while the proposed approach road ground level ranges from 6 to 155 m above. Hydrogeromorphology and transport network map for 10 km radius have been attached as annexure XI and XII.

Goa has a well-connected roadway network linking all places in the state. Improvements are planned for the national Highway system including widening NH 17 to four (4) lanes in the vicinity of the new airport. Other improvements envisioned in the Regional Plan for Goa 2021 include a new bifurcated NH-4 as shown on the Goa Road Network Map in annexure XIV.

The Konkan Railway Line runs virtually parallel to NH 17 near the airport and also connects Goa to the other states of India. The Regional Plan for Goa envisions improvements in the railway network including double tracking and connection to the proposed airport. The Railway network is illustrated in annexure XV.

During monsoon season water flows on and from the site through natural drains. There is no surface water available at the plateau elevation. Water supply for the airport is available from the nearby Kaina River (also called Chandel River) which is a tributary of Charpora River, in combination with the Tillari Irrigation Canal.

Sustainability strategies will be employed for the airport site and building development including rainwater harvesting, recycling, shading and solar options.

Details of Environmentally sensitive area falling within 15 Km from the project boundary is given in below Table – 2.1

**Table – 2.1 Environmentally sensitive areas within 15 Km from the project boundary**

| | |
|---|---|
| Archaeologically important places | None (within 10-km radius) |
| National Park / Wildlife Sanctuary | None (within 15 KM radius) |
| Reserved Forests<br>Protected Forests | Present (within 15 KM radius)<br>None (within 15 KM radius) |
| Defense Installations | None (within 10-km radius) |
| Critically polluted areas as identified by the CPCB | None |
| Areas occupied by sensitive man-made land uses (hospitals, schools etc) | None near project location |

## 2.2 TRAFFIC FORECAST

Dabolim faces a series of operational constraints that represent a serious inconvenience for users. These include:

1. The restriction on the hours of operations, with the hours between 08:30 and 13:00 on weekdays reserved for military training flights.
2. Congested air space during afternoon hours (particularly for international carriers)
3. Limited capacity of the existing passenger terminal building and aircraft parking apron, which leads to insufficient slots

4. Antiquated substandard facilities (no aerobridges, no air conditioning)
5. Lack of public transportation service

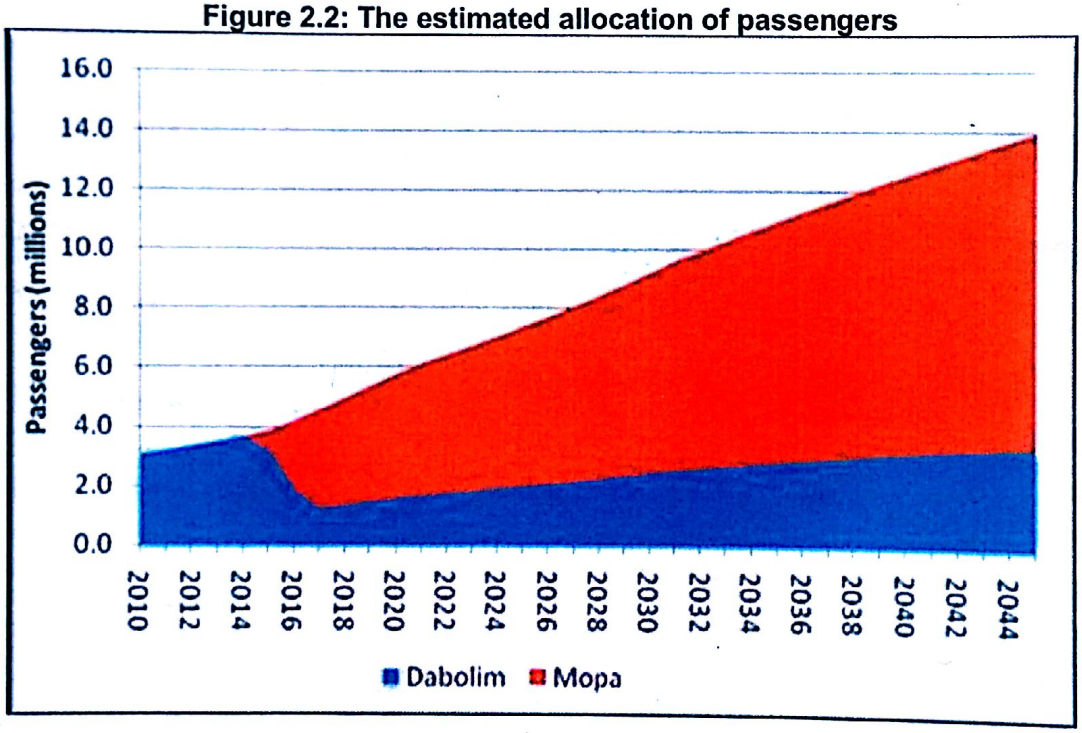
While the first two these issues are due to the fact that the airport shared with the Navy and are unlikely to resolved, Dabolim will soon be undertaking a major infrastructure expansion and improvement program that should significantly alleviate capacity and facilities issues.

It is estimated that once this program is complete, Dabolim should have the capacity to handle the following numbers of annual passengers, without reaching saturation or suffering a reduction in level of service:

- International: 1.47 million annual passengers
- Domestic: 7.44 million annual passengers

Figure 2.2 graphically illustrates the allocation process, with the top line representing the aggregate demand for the Goa system. In sum, over the medium to long-term, Mopa would account for approximately 70% of total passengers.

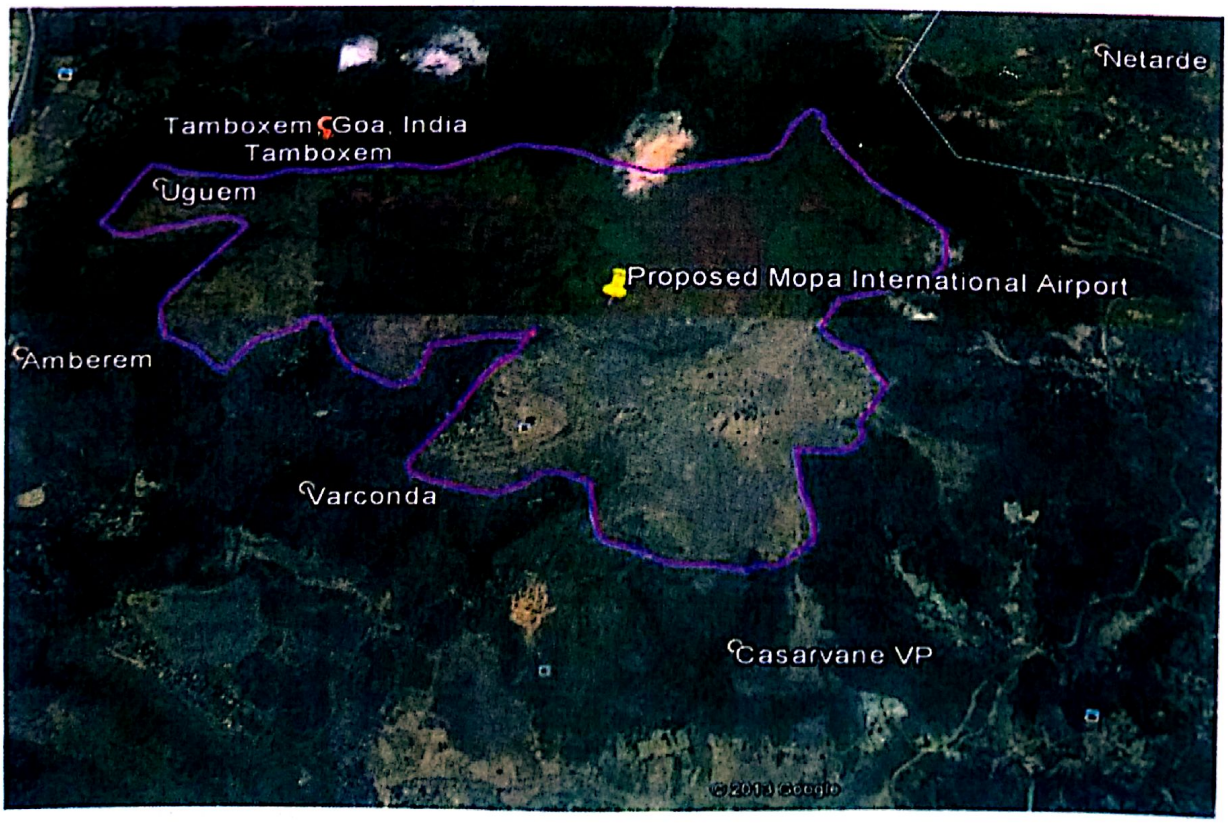
**Figure 2.2: The estimated allocation of passengers**




## 2.3 PROJECT DETAILS

Considering the requirements of present and future development, an area of 2271 acres is required for the proposed airport. The Government of Goa has negotiated for the purchase of 2100 acres to be utilized for development of the airport and commercial facilities at Mopa village. Government of Goa is the owner of the Mopa Airport land. All the compensation awards have been finalized and passed and the entire compensation amount of Rs. 54.79 crore has been placed with Economic Development Corporation, the disbursing agency for the release of claims. Proposed airport location is shown in figure 2.3.

**Figure 2.3: Proposed Airport Location**



### 2.3.1 LAND USE

The land is largely non-cultivated due to an out cropping of lateritic soil. Vegetation and trees are sparse at the site as illustrated in figure 2.6. A plantation is visible near the boundary of the site and the areas adjoining the site on the northern and eastern sides are reserved forest lands. Land use map for 10 km radius have been attached as annexure IX.

### 2.3.2. DRAINAGE PATTERN

The Airport site is well located with respect to the storm water drainage as it is a plateau at round 150 to 180m above the mean sea level. The natural drainage from site majorly falls towards the West and South side. The existing catchment divide and the drainage flow are shown in figure 2.7. The site can be divided into 6 catchments according to the number of outfalls at the boundary which drains to the West and South of the site. The remaining area (shown as hatched) drains to the North and East. With the development of Airport infrastructure, the area contributing to the North or East will reduce and the reduced area will then contribute to the West and South side outfalls. Drainage map for 10 km radius have been attached as annexure X.

### 2.3.3 RAINFALL PATTERN/ INTENSITY

**Meteorological data (Design Rainfall)**

Department of Meteorology, Goa has been contacted and 24 hour peak rainfall data for Pernem was obtained for past 5 years. The data obtained is given in Table 2.2 below.

**Table 2.2: Hour Peak Rainfall for Pernem, 2005-2010**

| Date | 24- hr peak rainfall (mm) |
|---|---|
| 25th July 2005 | 196 |
| 23rd July 2006 | 101 |
| 28th Sept 2007 | 178 |
| 11th Aug 2008 | 163 |
| 2nd July 2009 | 282 |
| 20th July 2010 | 166 |

### 2.3.4 WATER REQUIREMENT

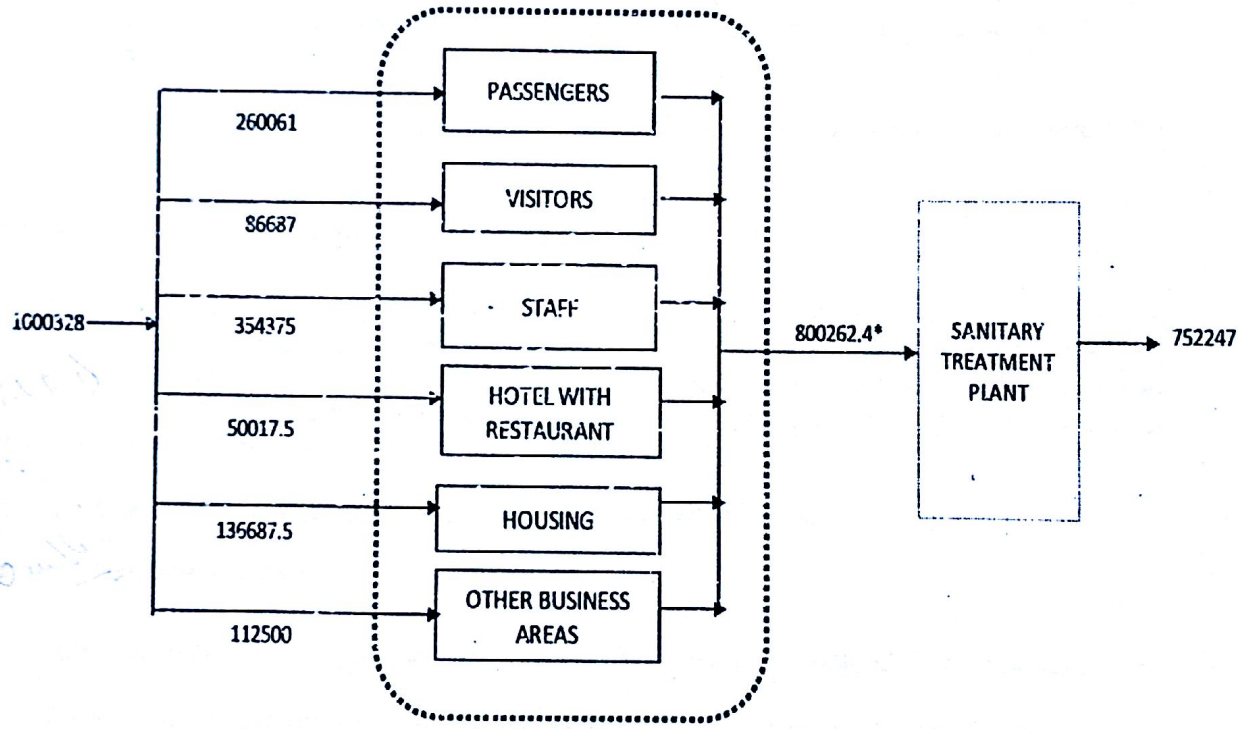
Total water demand for meeting the proposed airport is 1.2 MLD till phase I and 1.8 MLD including phase II. Water is sourced from Tillari Irrigation canal of irrigation Department, Dhargal division. However, there is a need for alternate water sources during closure of the canal for carrying out maintenance activity which is a normal case during monsoon season due to obstruction of canal as result of landslide at cut sections.

It is proposed that main source of water will be the Tillari Irrigation Canal. The water will be tapped at Chainage KM 6 near Chandel village where about 10 cu m of flow is available. The bed of the canal at proposed tapping point is about 28.5 m. The distance of raw water pumping main from tapping point to the proposed raw water storage and treatment site would be about 10 k m.

The standby source would be the Kalna River. The intake point would be near the intake point of the existing 15 MLD Chandel water supply project. A jackwell would be constructed in the river bed with pumping station. This river water will be used during closure of irrigation canal. The distance of raw water pumping main from tapping point to the proposed raw water storage and treatment site would be about 10 km. raw water is used after treatment with conventional water treatment plant having aeration, coagulation, clarrifloculation, filtration and chlorination.

The water distribution for the airport usage and water balance is shown in figure 2.4

**Figure 2.4 Water balance of phase 1 development:**




* The sewage generation is assumed as 80% of the water supply.

**# All values are mentioned in litres / day**

### 2.3.5 WASTE WATER GENERATION AND REUSE

Source of waste water generation from airport shall be the water supply demand, which will contribute to sewage generation, is 1.8 MLD and 3.0 MLD for the year 2030 and 2045. Therefore with the assumption of 80% of the water supply, the estimated sewage generation is therefore about 1.5 MLD and 2.4 MLD for the year 2030 and 2045, respactively. The maximum water demand and sewage generation beyond year 2045 is estimated as 6 MLD and about 5 MLD, respectively. The sewage from terminal building, catering, housing, hotels, commercial areas and other business areas would be collected through a gravity sewerage system leading to a sewage pumping station. Sewage treatment plants are designed for 10 years period in modular approach in phased manner as per CPHEEO Manual. The capacity of sewage treatment plant in phases is mentioned in table No. 2.3.

**Table No. 2.3: Sewage Treatment Plant**

| Year | 2025 | 2035 | 2045 | 2045 (max) |
|---|---|---|---|---|
| STP design capacity (cum) | 1120 | 1500 | 2400 | 5000 |

The sewage treatment plant will include tertiary treatment plant for re-using the treated effluent for irrigation of landscaping and garden areas. The aircraft waste will be chemically stabilized as primary treatment before blending into main packaged sewage treatment plant. The effluent quality will be suitable for use in irrigation of landscape / garden areas, flushing of urinals and toilets.

The disposal of untreated effluent will not be allowed at any circumstances. The necessary buffer storage tank will be provided for storage of wastewater during shut-down of the treatment plant for reason.

The excess sludge will be dewatered in dewatering system. The thickened sludge could be used as fertilizer in surrounding agriculture area.

### 2.3.6 SOLID WASTE GENERATION & DISPOSAL

Solid Waste generated from the various activities within the airport and outside in the nonaeronautical area need to be treated and disposed properly. The solid waste includes both bio-degradable waste and non bio-degradable waste. The solid waste that is generated from the airport area have been estimated of about 6.1 tonnes per day for phase I and 18.2 tonnes per day for phase IV.

Solid waste generated will be disposed in facilities owned by Government of Goa.

### 2.3.7 POWER REQUIREMENT

Total power required for the proposed airport is 40 MW. Power supply shall be sourced from

1. 220/110 KV independent High Tension (HT) lines from Western Grid: Tivim / Colvale/ Mapusa substation

2. Southern Grid: Karnataka / Amona – Sesa Goa – Ponda Substation

Emergency / generator power supply system shall be met from 5 numbers of generators each having capacity of 2000 KW.

## 2.4 PROPOSED AIRPORT FACILITIES

The proposed new International airport shall be capable of handling one B-747 one AB-300 aircraft load corresponding to a peak hour of 500 departing and 500 arriving passengers. The program outlined for the terminal has been designed to respond to both more immediate and longer-term needs anticipated for the airport. Programmatic analysis has considered facility requirements for the terminal at four key planning horizons: 2020, 2025, 2035 and 2045. This section will provide specific needs in more detail for the first and final phases – years 2020 and 2045. The sections below will address both functional and spatial requirements.

**Table 2.4: Peak Hour Numbers used in Terminal Program**

| | | Phase 2020 | Phase 2045 |
|---|---|---|---|
| Domestic Passengers | Enplaning (departing) | 986 pax | 2540 pax |
| | Deplaning (arriving) | 842 pax | 2171 pax |
| | Total | 1696 pax | 4373 pax |
| International Passengers | Enplaning (departing) | 593 pax | 1314 pax |
| | Deplaning (arriving) | 578 pax | 1282 pax |
| | Total | 921 pax | 2042 pax |
| Combined Passengers | Enplaning (departing) | 1394 pax | 3506 pax |
| | Deplaning (arriving) | 1003 pax | 2422 pax |
| | Total | 2222 pax | 5585 pax |

### 2.4.1 PHASE I DEVELOPMENT

The airport is initially designed with a level of service adequate to satisfy the demand of approximately 4.4 million passengers by providing Mopa International Airport with one runway and one processing terminal building with one associated pier.

**Runways**

In the opening phase, the airfield consists of one single runway with 095° northeast – 275° southwest orientations at the north of the site (designation 09/27) with a takeoff available distance of 3,750 meters and 60 meters of runway width to accommodate the super-jumbo A380 aircraft. The runway includes 7.5-metre wide shoulders at each side of the runway and beyond runway ends, blast pads of 60 x 60 meters at both ends of the runway will be provided with the objective of blast erosion protection. The terrain around the runway will be set up and graded as required by ICAO standards to provide the adequate runway strip with a longitudinal slope not exceeding 1.3% and downward transversal slope not exceeding 2.5%. At both ends of the runway strip a rectangle area of 240 m long x 60 m wide will be prepared for the runway end safety area. Based on the physical characteristics, the primary runway location will be in the north portion of the airport. The maximum land length available to locate the primary runway is 5,100 m.
The same has been shown in annexure VIII.

Parts of this 5100 m area is located in a vertical cliff area. Runways catering to the very large and wide-body aircraft categorized as code 4F require a precision approach landing system, either side of the runway end, to guide the aircraft for the final approach segment for landing. This instrument landing system, Category 1 (CAT I – ILS) requires a right-of-way of 500-900 m from the runway end along the runway centre line. The strip of land needed for the ILS will be made available as part of the Mopa airport site. The runway orientation of 95-275 is restricted by the terrain. The maximum available length with these limitations is 3750 m for full blown aircraft operation.

The Mopa International Airport configuration with an initially single runway and one full parallel taxiway assigned to the runway provides enough capacity to handle the air traffic forecast during Phase 1 and Phase 2.

**Runway System Requirements**

The characteristics of the proposed runway system of the Mopa International Airport are summarized in Table 2.8. The proposed airfield layout requests that one single runway will be operational for all four phases. The airport system would need an additional parallel taxiway to the runway in Phase 4.

Table No 2.5: Principal Characteristics of the Runway System

| Characteristic | Main Runway |
|---|---|
| Orientation | 95° NE - 275° SW |
| Designation | 09/27 |
| Centre Line to edge | 60 m |
| Threshold Displacement | 20 m |
| Shoulders | 7.5 m |
| Dimensions | 3,750 m x 60 m |

**NAVAID**

The runway will be equipped with both elevated and inset lights for at-all-time operations consisting of a CAT I approach system before both runway thresholds which comprises a row of lights, along the extension of the runway axis, to a distance of 900 m. The runway lighting system is completed with runway centerline inset lights, as recommended by DGCA CAR for precision approach category I when the runway is used by aircraft with high landing speeds or the distance between runway edge lights is greater than 50 meters, and runway edge elevated lights at both sides of the runway. Also, runway threshold lights and runway end lights will be installed. Blue elevated taxiway edge lights will be installed at each runway exit and taxiways. A PAPI approach slope indicator system of a 4-element wing bar placed on the left side of each runway will be installed. Both runway approaches are equipped with Instrument Landing System antennas Category I which consists of a localizer (LOC) antenna located 300 meters from runway ends and a glide path (GP/DME) antenna located 120 meters from runway centerline. A Doppler VHF on midirectional range (D-VOR) with an associated Distance Measurement Equipment (DME) will be installed for providing air navigation support to approaching and departing aircraft near the East border of the airport property. An airport surveillance radar providing monopulse secondary surveillance radar coverage to 120 NM (ASR/MSSR) for terminal approach control will be installed at the top of the cabin of the air traffic control tower,

**Runway Exits**

In order to optimize the runway occupancy time at this stage to an efficient level of 50 seconds, approximately, for large and heavy aircraft the runway will be provided with two rapid exits for each approach configuration at an angle of 30° located at 1800 and 2400 from each runway threshold. Also, two perpendicular runway exits at each runway end will be provided with a minimum distance between them of 97.5 meters according to taxiway minimum separation distances. For all runway exits, both perpendicular and at-angle, the taxiway width will be 25 meters plus paved shoulders at each side of the connectors of 17.5 meters wide. The runway exits will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the connectors.

**Taxiways**

The runway exits connect to a full parallel taxiway of 3750 meters long and 25 meters wide plus paved shoulders of 17.5 meters wide at each side of the taxiway, with a PCN value between 62 and 107, depending on the type of pavement and the CBR values of the sub-grade. The taxiway will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway. From the main parallel taxiway two perpendicular taxiway connectors 25 meters wide plus paved shoulders of 17.5 meters at each side of the taxiways wide link up to the main aircraft apron. An additional taxiway connector perpendicular to the primary runway and parallel taxiway links to the Naval base. All taxiway connectors will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway connectors.

**Commercial Apron**

In Phase I, the main commercial aircraft parking apron will have a paved surface area of approximately 114,000 m2, which includes the following elements in compliance with the Minimum Technical Requirements:

- Two (2) remote aircraft stands;
- Eight (8) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and
- Vehicle service roads.

**Cargo Apron**

The cargo apron is located at about 500 meters left of the terminal building and connected by a taxiway of 25 m wide plus shoulders of 17.5 m wide. The cargo apron is designed to accommodate up to 1 wide-body freighters at the same time with a total area of 5,250 m2 including:

- A unit loading area of 6 m wide in front of the cargo building terminal,
- A cargo road for ground ramp vehicles of 12 wide,
- A staging area of 18 m wide for storage of ground handling equipment,
- An aircraft nose loading area of 16 m wide,
- Aircraft stand of 75 m long, and
- An apron taxi lane at 50.5 m from the cargo aircraft stands borderline.
- A Cargo terminal building of 5000 m2

The cargo apron area is extended 17.5 meters with paved shoulders and protected of any obstacle within a strip of 57.5 meters with a graded area of 30 m so that the transverse slope does not exceed 2.5% upward or 5% downward from the apron taxi lane. Blue elevated edge lights will be installed at both the taxiway connecting to the commercial apron and the entire shoulder of the cargo apron.

**Aircraft Maintenance Area**

The area required for these activities, including apron and hangars, is expected to be 15,300 m2. The aircraft maintenance facilities are estimated to provide space for 1 hangar. Blue elevated edge lights will be installed at both the taxiway connecting to the hangar apron and the entire shoulder of the hangar apron.

**ATC**

Following international standards recommendations, an area of 5,000 m2 is reserved adjacent to the west side of the airport located right next to the Cargo Area, for accommodating the technical building of aeronautical services, car parking and the control tower. The control tower will have a total height to the ATC cabin of 50 meters.

**General Aviation**

The general aviation area is located across the commercial apron right of the terminal building. The apron area required General Aviation is 44,000 m2. It also has a general aviation terminal of size 2,500 m2 and two hangars for general and business aviation purposes with size 2,500 m2. The Airport Layout Plan (ALP) is attached as annexure VIII.

**MOPA AIRPORT PARKING DEMAND FORECAST**

| Vehicle Type | Parking Spaces Required | | | |
|---|---|---|---|---|
| Car | 996 | 1,302 | 2,114 | 2,934 |
| 2 Wheelers | 318 | 415 | 674 | 935 |
| Bus | 51 | 67 | 109 | 151 |

## 2.4.2 PHASE II DEVELOPMENT

In the second Phase the airport designed with a level of service adequate to satisfy the demand of approximately 5.8 million passengers by providing Mopa International Airport an expansion to the associated pier.

**Commercial Apron**

In Phase II, the main commercial aircraft parking apron will have a paved surface area of approximately 159,600 $m^2$, which includes the following elements in compliance with the Minimum Technical Requirements:

- Three (3) remote aircraft stands;

- Eleven (11) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and
- Vehicle service roads.

### 2.4.3 PHASE III DEVELOPMENT

In the third Phase the airport designed with a level of service adequate to satisfy the demand of approximately 9.4 million passengers by providing Mopa International Airport an expansion to the asscciated pier.

**Taxiways**

From the main parallel taxiway a single perpendicular taxiway located at a distance of 1000 m from the existing taxiway connector connectors, 25 meters wide plus paved shoulders of 17.5 meters at each side of the taxiways, link up to the main aircraft apron. All taxiway connectors will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway connectors.

**Commercial Apron**

In Phase III, the main commercial aircraft parking apron will have a paved surface area of approximately 182,400 $m^2$, which includes the following elements in compliance with the Minimum Technical Requirements:

- Three (3) remote aircraft stands;
- Thirteen (11) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and
- Vehicle service roads.

**Cargo Apron**

The cargo apron is located at about 500 meters left of the terminal building and connected by a taxiway of 25 m wide plus shoulders of 17.5 m wide. The cargo apron is designed to accommodate up to 1 wide-body freighters at the same time with a total area of 10, 500 $m^2$ including:

- A unit loading area of 6 m wide in front of the cargo building terminal,
- A cargo road for ground ramp vehicles of 12 wide,
- A staging area of 18 m wide for storage of ground handling equipment,
- An aircraft nose loading area of 16 m wide,
- Aircraft stand of 75 m long, and
- An apron taxi lane at 50.5 m from the cargo aircraft stands borderline.
- A Cargo terminal building of 8000 $m^2$

**Aircraft Maintenance Area**

The area required for these activities, including apron and hangars, is expected to be 30,000 $m^2$. The aircraft maintenance facilities are estimated to provide space for one hangar.

**General Aviation**

The general aviation area is located across the commercial apron right of the terminal building. In Phase III, two more hangars for general and business aviation purposes with size 2,500 $m^2$.

### 2.4.4 PHASE IV DEVELOPMENT

In the fourth Phase the airport designed with a level of service adequate to satisfy the demand of approximately 13.1 million passengers.

**Taxiways**

A partial second parallel taxiway will link the two perpendicular taxiway connectors located a distance of 1000 m apart. The partial parallel taxiway will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway connectors.

**Commercial Apron**

In Phase IV, the main commercial aircraft parking apron will have a paved surface area of approximately 239,400 m2, which includes the following elements in compliance with the Minimum Technical Requirements:

- Four (4) remote aircraft stands;
- Seventeen (17) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and
- Vehicle service roads.

## 2.5 FUEL STORAGE

The jet fuel requirements depending on the number of annual aircraft operations and the application are given below.

- Fuel tank volume capacity of approximately 3,000 $m^3$
- Storage capacity for up to 7 days
- Average fuel uplift of 8.5 $m^3$ per aircraft departure.

| Period | Fuel Tank ($m^3$) | Number of Fuel Tanks |
|---|---|---|
| **2020** | 6,331 | 2 |
| **2025** | 8,085 | 3 |
| **2035** | 12,809 | 4 |
| **2045** | 17,782 | 6 |

# CHAPTER 3

# ANALYSIS OF ALTERNATIVES

## 3.1 DESCRIPTION OF ALTERNATIVES:

As described in chapter 2, Based on the expected traffic and capabilities of the existing Airport at Dhabolim the following two options were proposed for development:

A) Option – 1

To develop a new International Terminal at Mopa with the following salient features:

- Design Year : 2020
- Total cost: INR 8748 million.
- Land Requirement : 2271 acres

B) Option – 2

Augmentation of the existing International and Domestic Terminal and utilise it as a new international Terminal.

However due to Capacity constraints and military restrictions Option – 1 is considered as the feasible workable solution.

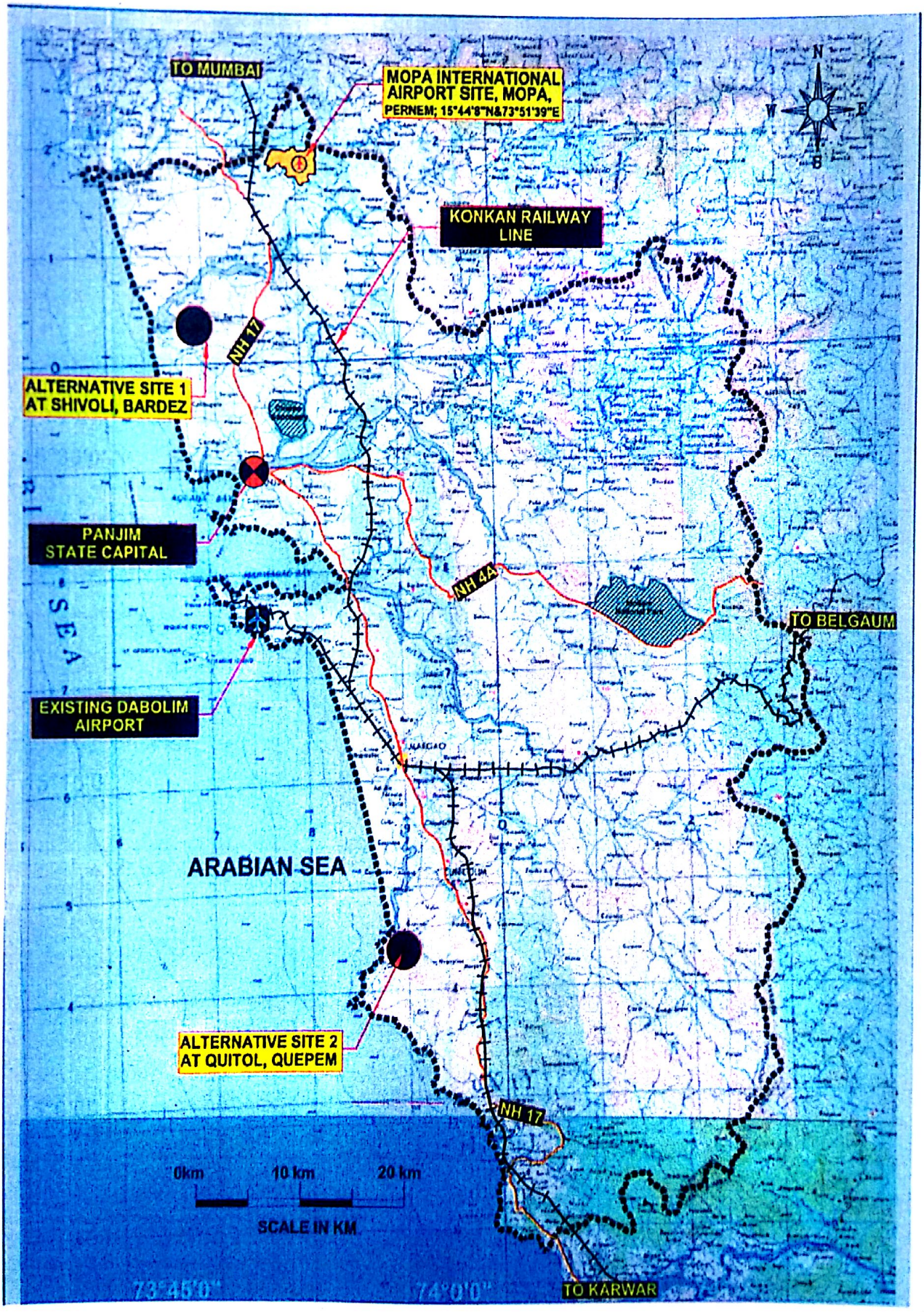
**Alternative Sites:**

Following three sites were analyzed for development of the international airport:

- Site 1: at Mopa – 4500 acres (2271 acres revised)
- Site2: at Quitol – 2000 acres
- Site3: at Siolim – 1000 acres

These sites are shown in figure no 3.1. Based on site selection study, Site 1 was found most favorable.

Figure 3.1 Alternative sites



## 3.2 Approach Road:

The access to the Greenfield Airport at Mopa is proposed near 495 km of the National Highway 17. A 4 lane approach road from NH-17 to Mopa Airport site has been proposed with a trumpet interchange at NH-17, a bridge over of the Konkan Railway line and various viaducts and other structures. The proposed cross-section is shown Appendix A.

A .traverse survey has been conducted along the corridor previously identified for the approach road. The alignment was found to result in a substantial gradient, and require some realignment to reach the design speed of 65 kmph.

Preliminary survey of traversing suggested requirement of realignment near chainage 0+000 to 1+000 due alignment of canal falls within approach road corridor. Further minor realignment was required to follow design speed 65kmph. Profile of selected corridor in the last section indicated limiting gradient of 5% in substantial length (2250.0m) which further warranted locking for other options of approach road alignments.

In view of above alignment alternative study with option-1, Option-2, Option-3 along with Option 1-b (extreme case i.e. followed existing designated land corridor with ruling gradients) has been done.

Option1-b shows huge cut and fill including viaduct length more than 3.0km with extraordinary height of viaduct in turns preliminary cost would be more than 2.5 times than alignment alternative option-2. Alignment alternative option-3 passes through forest area nearby chainage 7+300 both sides. It is learnt that this land would be earmarked for settlement of people whose land would be acquired in land acquisition requirement of this project. Alignment alternative option-2 has come out better option for approach road alignment with reduce length of viaducts among all the alternative and ease in approach end section gradients to 3.5%. This option comes out with better highway geometrics with least cost.

All these alignment options were discussed and presented in Draft Master Plan stage and Consultants Preferred alignment option-2 with due weightage of ease in gradients in last approach section, reduce length in viaduct in turns reduce cost of alignment alternative of Option-2. Approval of alignment option-2 was conveyed by client on submission/presentation of draft master plan.

Topographic survey along the corridor of approved option has been conducted and preliminary plan and profile drawings have been prepared for approved option accordingly.

# CHAPTER 4

# DESCRIPTION OF ENVIRONMENT

## 4.0 BASE LINE DATA COLLECTION

The present chapter highlights various aspects of baseline data and its analysis in the light of proposed project facilities. M/s. EMTRC Consultants Private Limited had been entrusted the task of ambience air, water, soil and noise level monitoring of the area of influence near the proposed airport for a period of three moths, starting from October 2011 to December 2011. Data thus collected has been utilized here to establish baseline quality of various environmental parameters.

## 4.1 AIR ENVIRONMENT

Total Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM) during construction phase and unburnt hydrocarbons (HC) and Oxides of Nitrogen ($NO_x$) during operation phase are the major pollutants in this kind of project. Ambient air quality collected at six (6) locations by EMTRC Consultants Private Limited, within 10 kms around the airport is used as baseline levels. A detailed description of the observations is given in the following sections:

### 4.1.1 Micro Meteorology

Micrometeorology with respect to wind speed, wind direction, and temperature, recorded at meteorological station in the months of October, November and December 2011 is summarized in the following sections.

#### 1. Temperature

The temperature varied between 23.0 – 33.0°C in the months of October, November and December. The variation of temperature remained same in these three months, which are normally considered as winter season.

#### 2. Wind Speed and Direction

Generally light to moderate winds prevails through out these months. The predominant wind directions were North-East. The wind rose diagrams for these three months are shown in Figure 4.1 a, b and c.

**Figure 4.1a: Wind rose diagram (October 2011)**

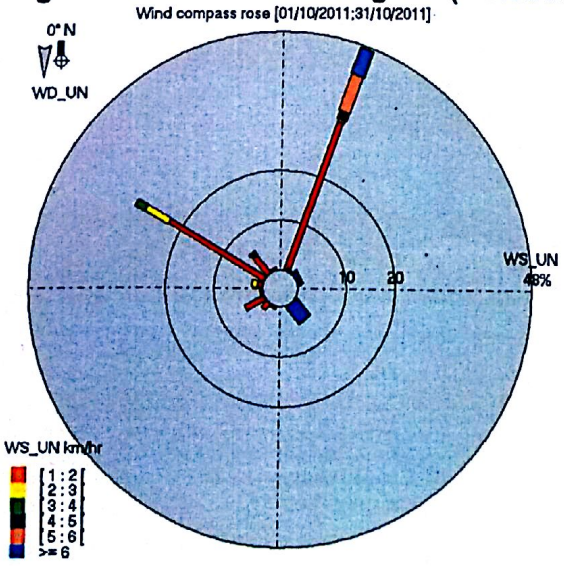


**Figure 4.1b: Wind rose diagram (November 2011)**

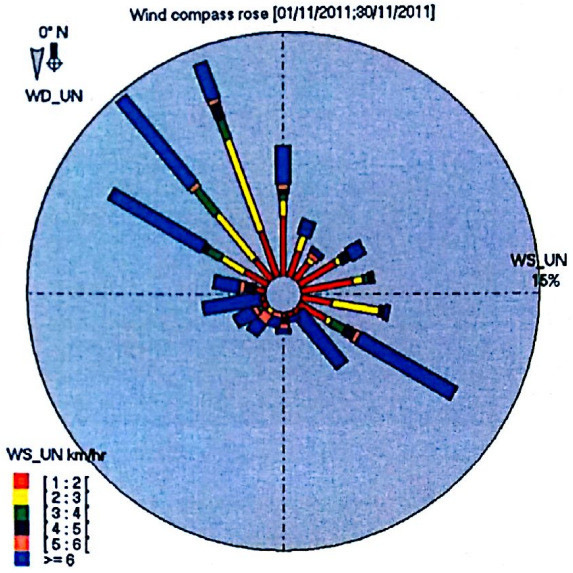
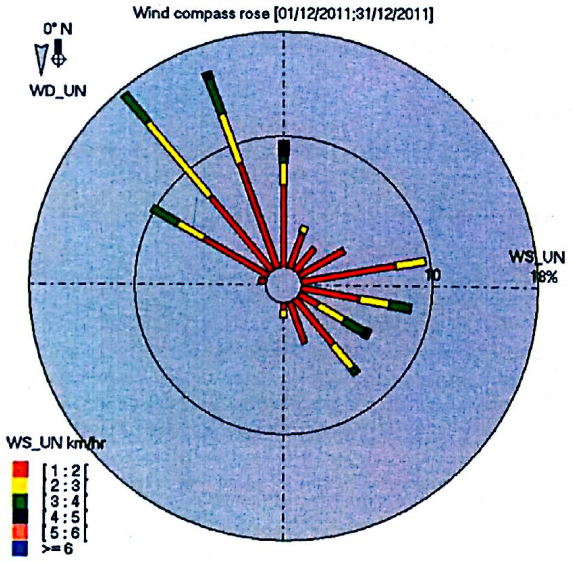



**Figure 4.1c: Wind rose diagram (December 2011)**




### 4.1.2 AMBIENT AIR QUALITY

Ambient air quality was monitored in terms of SPM, RPM, $SO_2$, $NO_X$, CO and HC at six locations. The locations of AAQ monitoring stations are at Sinechaadvin, Katwal, Mopa village, Pernem, Nagzor and Patradevi within 10 km of study area. The AAQ locations are shown in figure 4.2.

A brief summary of all recorded parameters, monitored during winter season (October - December) are discussed in the following subsections.

**Figure 4.2: Ambient Air Quality monitoring locations**

### A) Suspended Particulate Matter (SPM / $PM_{10}$)

SPM values recorded at various stations ranged between 35- 47µg/$m^3$ with minimum values varying between 29-41µg/$m^3$ and maximum values varying between 41- 53 µg/$m^3$. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 100 µg/$m^3$ prescribed for residential and rural areas. SPM values monitored are given in Table 4.1.

**Table 4.1: Ambient Air Quality at Various Monitoring Stations (SPM / $PM_{10}$)**

| Locations | Mean | Max | Min |
|---|---|---|---|
| A1 | 40 | 46 | 35 |
| A2 | 40 | 46 | 35 |
| A3 | 35 | 41 | 29 |
| A4 | 43 | 51 | 36 |
| A5 | 47 | 53 | 41 |
| A6 | 41 | 48 | 35 |

### B) Respirable Particulate Matter (RPM / $PM_{2.5}$)

RPM values recorded at various stations ranged between 18 -23 µg/$m^3$ with minimum values varying between 14 - 18 µg/$m^3$ and maximum values varying between 23- 28 µg/$m^3$. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 60 µg/$m^3$ prescribed for residential and rural areas. RPM values monitored are given in Table 4.2.

**Table 4.2: Ambient Air Quality at Various Monitoring Stations (RPM / $PM_{2.5}$)**

| Locations | Mean | Max | Min |
|---|---|---|---|
| A1 | 20 | 24 | 15 |
| A2 | 20 | 24 | 15 |
| A3 | 18 | 23 | 14 |
| A4 | 22 | 26 | 18 |
| A5 | 23 | 28 | 18 |
| A6 | 20 | 24 | 16 |

### C) Sulphur Dioxide ($SO_2$)

$SO_2$ values recorded at various stations ranged between 10.2 -14.4 µg/$m^3$ with minimum values varying between 7.6- 9.8 µg/$m^3$ and maximum values varying between 13.2 –18.5 µg/$m^3$. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 80 µg/$m^3$ prescribed for residential and rural areas. $SO_2$ values monitored are given in Table 4.3.

**Table 4.3: Ambient Air Quality at Various Monitoring Stations (SOX)**

| Locations | Mean | Max | Min |
|---|---|---|---|
| A1 | 10.2 | 13.2 | 7.6 |
| A2 | 10.2 | 13.2 | 7.6 |
| A3 | 10.3 | 13.6 | 8.2 |

| | | | |
|---|---|---|---|
| A4 | 12.6 | 15.6 | 9.3 |
| A5 | 14.4 | 18.5 | 9.8 |
| A6 | 12.4 | 16.2 | 8.3 |

**D) Oxides of Nitrogen ($NO_x$)**

$NO_x$ values recorded at various stations ranged between 13 - 16.3 µg/m$^3$ with minimum values varying between 9 - 11.8 µg/m$^3$ and maximum values varying between 16.3 – 21.8 µg/m$^3$. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 80 µg/m$^3$ prescribed for residential and rural areas. $NO_x$ values monitored are given in Table 4.4.

**Table 4.4: Ambient Air Quality at Various Monitoring Stations (NOX)**

| Locations | Mean | Max | Min |
|---|---|---|---|
| A1 | 13 | 17.8 | 9.0 |
| A2 | 13 | 17.8 | 9.0 |
| A3 | 13 | 16.3 | 9 |
| A4 | 16.3 | 21.8 | 11.8 |
| A5 | 16.2 | 21.2 | 10.5 |
| A6 | 14.6 | 18.2 | 10.3 |

Both CO and HC were found <100 µg/m$^3$ at all the locations during the monitoring period.

## 4.2 WATER ENVIRONMENT

The water requirement for the proposed Greenfield airport will be met with the Tiliari Irrigation canal. The water will be tapped at chainage 6 km near Chandel village where about 10 cu m of flow is available.

The standby source would be the Kalna river, which is tributary of Chapora river and Tillari irrigation canal. As the project will be implemented in four phases, the estimated water requirements for the year 2020, 2030, 2045 and beyond 2045 are 1MLD, 1.8 MLD, 3 MLD and 6 MLD respectively. Water is used for domestic purposes by the passengers, visitors, staff etc.

The ground water quality is measured at four locations i.e. Mopa village, Pernem, Dargal and Patradevi within 10 km of study area. These are reported in Tables 4.5a and 4.5b. The surface water quality is measured at three locations Chapora river, Tiraikol river and Nala near Mopa village within 10 km of study area. These are reported in Table 4.6. The water sampling locations are depicted in figure 4.3.

**Figure 4.3: Water Sampling Locations**

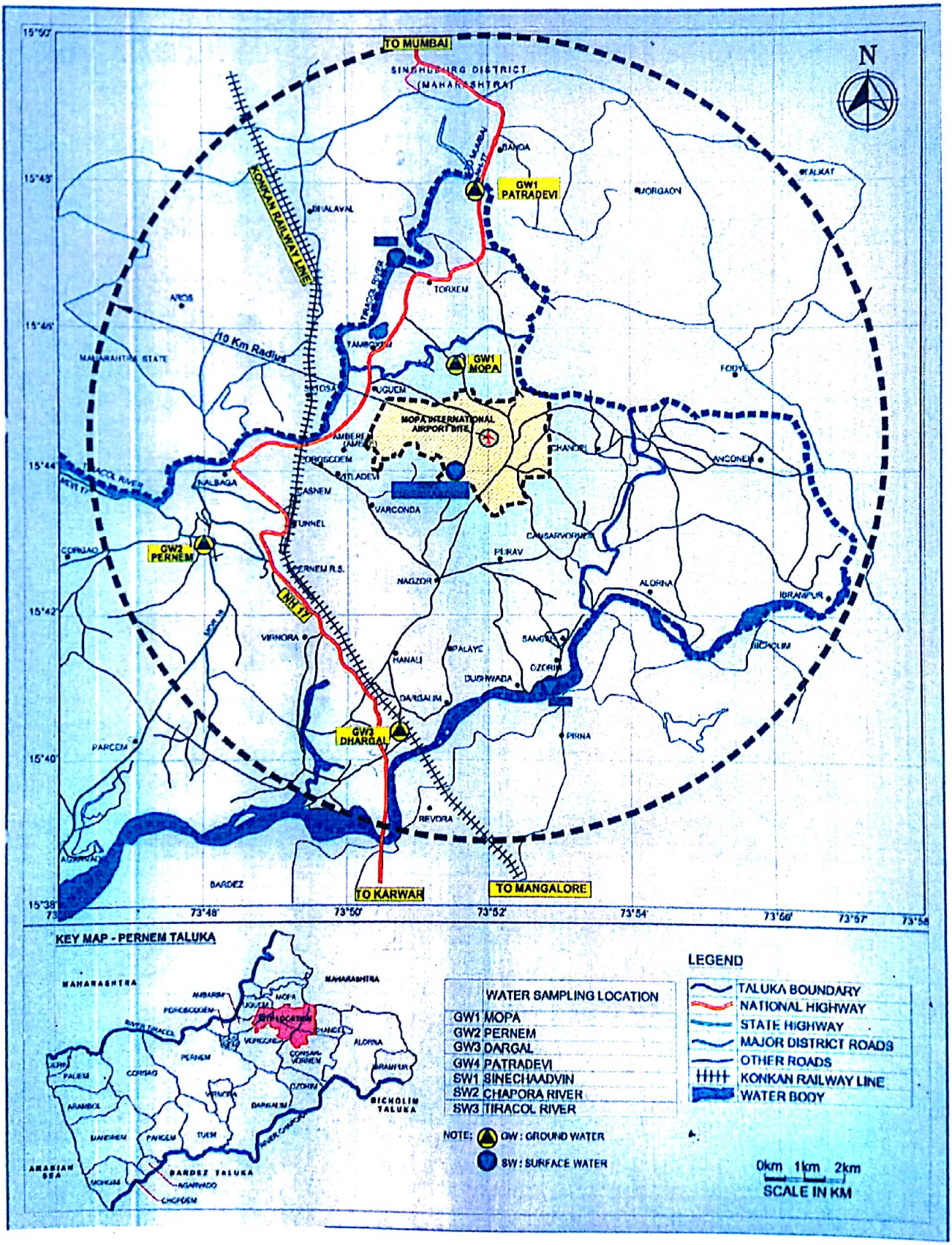


**Table 4.5a: Ground Water Quality of Mopa village and Pernem.**

| Sr. No. | Parameters | Unit | Test Methods | Mopa Village (Dug well) | Pernem (Dug well) | Permissible limit IS:10500: 1991 |
|---|---|---|---|---|---|---|
| 1 | Colour | Hazen Unit | APHA-2120B | Colourless | Colourless | 25 |
| 2 | Odour | - | APHA-2150B | Unobjectionable | Unobjectionable | Unobjectionable |
| 3 | pH | - | APHA-4500 | 7.70 | 6.62 | 6.5 – 8.5 |
| 4 | Conductivity | µmhos/cm | APHA-2510 | 260 | 190 | - |
| 5 | Turbidity | NTU | APHA-2030B | 2.0 | 1.0 | 10 |
| 6 | Total Dissolved Solids | mg/l | APHA-2540B | 182 | 132 | 2000 |
| 7 | Total Hardness as $CaCO_3$ | mg/l | APHA-2340C | 90 | 40 | 600 |
| 8 | Calcium as Ca | mg/l | APHA-4500B | 28 | 8 | 200 |
| 9 | Magnesium as Mg | mg/l | APHA-4500B | 4.8 | 4.8 | 100 |
| 10 | Chlorides as Cl | mg/l | APHA-4500B | 18 | 35 | 1000 |
| 11 | Nitrates as $NO_3$ | mg/l | APHA-4500 | 5.8 | 01 | 100 |
| 12 | Phenolic compound | mg/l | APHA-5230D | <0.001 | <0.001 | 0.001 |
| 13 | Sulphate as $SO_4$ | mg/l | APHA-4500E | 16 | 04 | 400 |
| 14 | Fluoride as F | mg/l | APHA-4500D | 0.48 | 0.23 | 1.5 |
| 15 | Phosphates as $PO_4$ | mg/l | APHA-4500C | 0.028 | 0.018 | 0.3 |
| 16 | Iron as Fe | mg/l | APHA-3111B | 0.018 | 0.012 | 1.0 |
| 17 | Copper as Cu | mg/l | APHA-3111B | <0.02 | <0.02 | 1.5 |
| 18 | Lead as Pb | mg/l | APHA-3111B | <0.01 | <0.01 | 0.05 |
| 19 | Manganese as Mn | mg/l | APHA-3111B | <0.05 | <0.05 | 0.3 |
| 20 | Zinc as Zn | mg/l | APHA-3111B | 0.28 | 0 20 | 15 |
| 21 | Chromium | mg/l | APHA-3111B | <0.05 | <0.05 | 0.05 |
| 22 | Nickel as Ni | mg/l | APHA-3111B | <0.01 | <0.01 | 0.05 |
| 23 | Oil & Grease | mg/l | APHA-5520D | Nil | Nil | 0.03 |
| 24 | Cadmium as Cd | mg/l | APHA-3111B | <0.01 | <0.01 | 0.01 |
| 25 | Mercury as Hg | mg/l | APHA-3111B | <0.001 | <0.001 | 0.001 |
| 26 | Arsenic as As | mg/l | APHA-3111B | <0.025 | <0.025 | 0.05 |
| 27 | Total coliform | MPN/100ml | APHA-9230B | Nil | Nil | Nil |

**Table 4.5b: Ground Water Quality of Dargal and Patradevi**

| Sr. No. | Parameters | Unit | Test Methods | Dargal (Dug well) | Patradevi (Dug well) | Permissible limit IS:10500: 1991 |
|---|---|---|---|---|---|---|
| 1 | Colour | Hazen Unit | APHA-2120B | Colourless | Colourless | 25 |
| 2 | Odour | - | APHA-2150B | Unobjectionable | Unobjectionable | Unobjectionable |
| 3 | pH | - | APHA-4500 | 7.10 | 6.64 | 6.5 – 8.5 |
| 4 | Conductivity | µmhos/cm | APHA-2510 | 150 | 190 | - |
| 5 | Turbidity | NTU | APHA-2030B | 1.0 | 2.0 | 10 |
| 6 | Total Dissolved Solids | mg/l | APHA-2540B | 102 | 128 | 2000 |
| 7 | Total Hardness as $CaCO_3$ | mg/l | APHA-2340C | 40 | 50 | 600 |
| 8 | Calcium as Ca | mg/l | APHA-4500B | 12 | 14 | 200 |
| 9 | Magnesium as Mg | mg/l | APHA-4500B | 2.4 | 3.6 | 100 |
| 10 | Chlorides as Cl | mg/l | APHA-4500B | 40 | 25 | 1000 |
| 11 | Nitrates as $NO_3$ | mg/l | APHA-4500 | 2.1 | 9.6 | 100 |
| 12 | Phenolic compound | mg/l | APHA-5230D | <0.001 | <0.001 | 0.001 |
| 13 | Sulphate as $SO_4$ | mg/l | APHA-4500E | 11.2 | 24 | 400 |
| 14 | Fluoride as F | mg/l | APHA-4500D | 0.36 | 0.26 | 1.5 |
| 15 | Phosphates as $PO_4$ | mg/l | APHA-4500C | 0.019 | 0.038 | 0.3 |
| 16 | Iron as Fe | mg/l | APHA-3111B | 0.022 | 0.021 | 1.0 |
| 17 | Copper as Cu | mg/l | APHA-3111B | <0.02 | <0.02 | 1.5 |
| 18 | Lead as Pb | mg/l | APHA-3111B | <0.01 | <0.01 | 0.05 |
| 19 | Manganese as Mn | mg/l | APHA-3111B | <0.05 | <0.05 | 0.3 |
| 20 | Zinc as Zn | mg/l | APHA-3111B | 0.22 | 0.14 | 15 |
| 21 | Chromium | mg/l | APHA-3111B | <0.05 | <0.05 | 0.05 |
| 22 | Nickel as Ni | mg/l | APHA-3111B | <0.01 | <0.01 | 0.05 |
| 23 | Oil & Grease | mg/l | APHA-5520D | Nil | Nil | 0.03 |
| 24 | Cadmium as Cd | mg/l | APHA-3111B | <0.01 | <0.01 | 0.01 |
| 25 | Mercury as Hg | mg/l | APHA-3111B | <0.001 | <0.001 | 0.001 |
| 26 | Arsenic as As | mg/l | APHA-3111B | <0.025 | <0.025 | 0.05 |
| 27 | Total coliform | MPN/100ml | APHA-9230B | Nil | Nil | Nil |

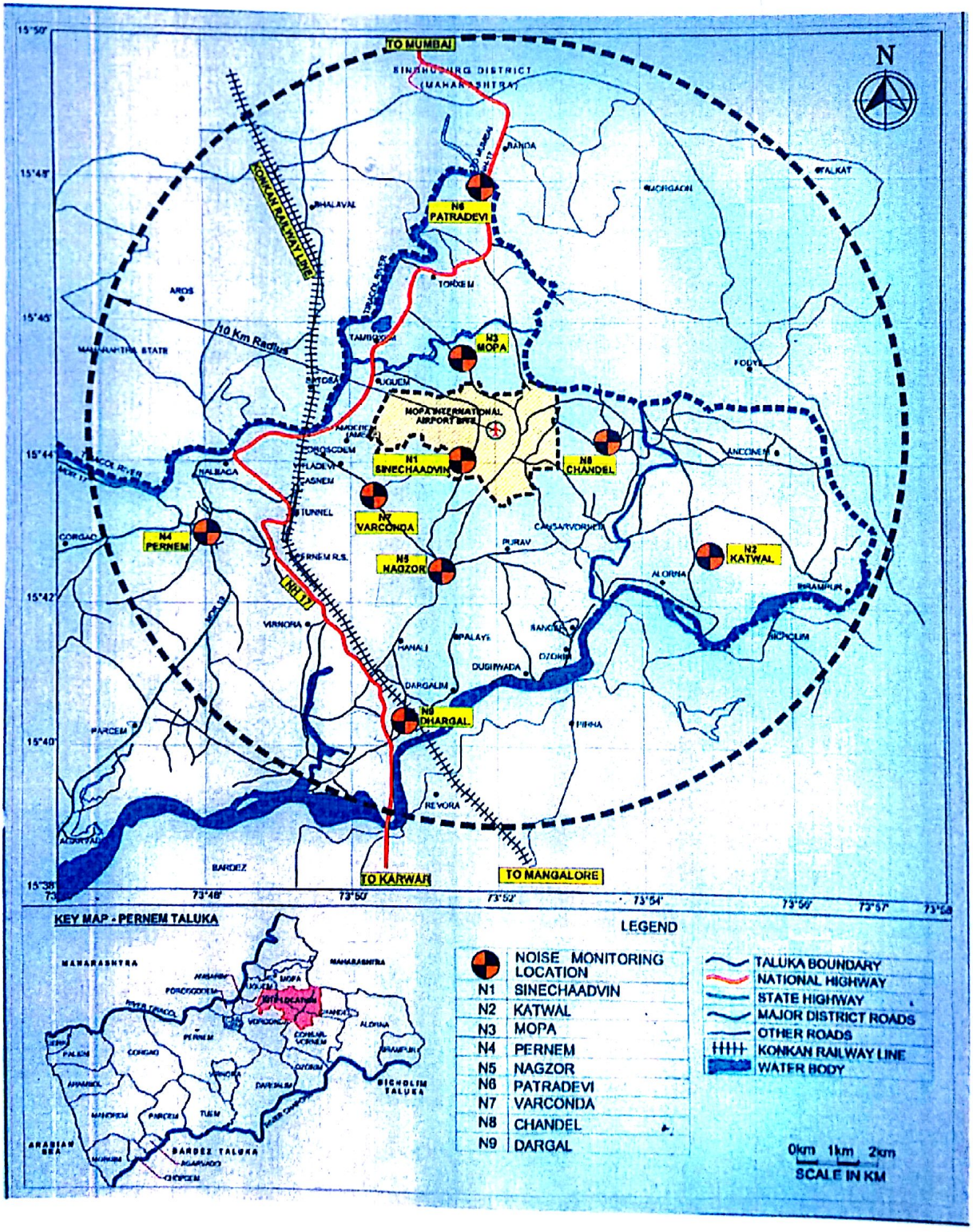
**Table 4.6: Surface Water Quality**

| Sr. No. | Parameters | Unit | Test Methods | Chapora River | Tiraikol River | Nala Near Mopa Village |
|---|---|---|---|---|---|---|
| 1 | pH | - | APHA-4500 | 7.25 | 7.44 | 6.92 |
| 2 | Conductivity | µmhos/cm | APHA-2510 | 13356 | 15300 | 340 |
| 3 | Colour | Hazen Unit | APHA-2120B | Colourless | Colourless | Colourless |
| 4 | Odour | - | APHA-2150B | Unobjectionable | Unobjectionable | Unobjectionable |
| 5 | Turbidity | NTU | APHA-2030B | 4 | 6 | 3 |
| 6 | Total Dissolved Solids | mg/l | APHA-2540B | 8690 | 9980 | 258 |
| 7 | Suspended solids | mg/l | APHA-2540D | 24 | 28 | 14 |
| 8 | Total Alkalinity | mg/l | APHA-2320B | 150 | 120 | 110 |
| 9 | Total Hardness as $CaCO_3$ | mg/l | APHA-2340C | 1460 | 1780 | 80 |
| 10 | Dissolved Oxygen | mg/l | APHA-4500C | 5.2 | 4.9 | 5.4 |
| 11 | BOD, 5days 20$^0$C | mg/l | APHA-5210B | 4.8 | 5.4 | 4.6 |
| 12 | COD | mg/l | APHA-5220C | 12 | 16 | 12 |
| 13 | Calcium as Ca | mg/l | APHA-4500B | 168 | 224 | 24 |
| 14 | Magnesium as Mg | mg/l | APHA-4500B | 252 | 306 | 4.9 |
| 15 | Chlorides as Cl | mg/l | APHA-4500B | 2800 | 3640 | 18 |
| 16 | Sulphate as $SO_4$ | mg/l | APHA-4500E | 430 | 530 | 12 |
| 17 | Nitrates as $NO_3$ | mg/l | APHA-4500 | 12.5 | 19.2 | 4.5 |
| 18 | Fluoride as F | mg/l | APHA-4500D | 0.22 | 0.28 | 0.28 |
| 19 | Phenolic compound | mg/l | APHA-5230D | <0.001 | <0.001 | <0.001 |
| 20 | Arsenic | mg/l | APHA-3114 | <0.025 | <0.025 | <0.025 |
| 21 | Mercury | mg/l | APHA-3112 | <0.01 | <0.01 | <0.01 |
| 22 | Cadmium | mg/l | APHA-3111B | <0.01 | <0.01 | <0.01 |
| 23 | Chromium | mg/l | APHA-3111B | <0.05 | <0.005 | <0.05 |
| 24 | Iron as Fe | mg/l | APHA-3111B | 0.018 | 0.016 | 0.022 |
| 25 | Copper as Cu | mg/l | APHA-3111B | <0.02 | <0.02 | <0.02 |
| 26 | Lead as Pb | mg/l | APHA-3111B | <0.01 | <0.01 | <0.01 |
| 27 | Manganese as Mn | mg/l | APHA-3111B | <0.05 | <0.05 | <0.05 |
| 28 | Zinc | mg/l | APHA-3111B | 1.2 | 0.92 | 0.26 |
| 29 | Oil & Grease | mg/l | APHA-4500D | Nil | Nil | Nil |
| 30 | Total coliform | MPN/100ml | APHA-9230B | 180 | 260 | 160 |

## 4.3 NOISE ENVIRONMENT:

Noise levels were measured at nine different locations within study area. The noise monitoring locations are depicted in figure 4.4. The computed noise level parameters, $L_{day}$ and $L_{night}$ for all the nine sampling locations presented in Table 4.7.

**Figure 4.4: Noise Monitoring Locations**



**a) Day time Noise Levels**

The noise level in all the locations ranged from 43.7 - 53.8 dB (a), with the maximum (53.8) being recorded in Pernem. The noise levels were observed within the limits in their respective categories.

**b) Night time Noise Levels**

The noise level in all the locations ranged from 39.5 – 44 dB(a), with the maximum 44 being recorded in Patradevi. The noise levels were observed within the limits in their respective categories.

**Table 4.7: Ambient Noise Level [in Leq dB(A)]**

| Sl. No. | Name of Location | Day Time | Night Time |
|---|---|---|---|
| 1 | Sinechaadvin | 45.6 | 40.4 |
| 2 | Katwal | 48.8 | 41.2 |
| 3 | Mopa | 43.7 | 39.5 |
| 4 | Pernem | 53.2 | 43.5 |
| 5 | Nagzor | 52.8 | 42.5 |
| 6 | Patradevi | 53.8 | 44.0 |
| 7 | Varconda | 52.8 | 42.1 |
| 8 | Chandel | 48.5 | 41.2 |
| 9 | Dargal | 51.8 | 40.9 |

The standard ambient noise levels in different categories are given below in Table 4.8.

**Table 4.8: Noise Level [in Leq dB(A)] (Standard)**

| Area code | Category of area | Limits in db (A) Leq | |
|---|---|---|---|
| | | Day time | Night time |
| A | Industrial area | 75 | 70 |
| B | Commercial area | 65 | 55 |
| C | Residential area | 55 | 45 |
| D | Silence zone | 50 | 40 |

## 4.4 LAND ENVIRONMENT:

Surrounding land use of the airport site is predominantly forest land. The northern and eastern side of site is reserve forest areas, whereas western side is barren and village cultivated land. The existing land use plan is attached as annexure VII

### 4.4.1 SOIL ENVIRONMENT

Soil quality was measured at five different agricultural fields within study area and is given in table 4.9. The soil sampling locations are depicted in figure 4.5.

**Figure 4.5: Soil Sampling Locations**

Table 4.9: Soil quality of agriculture fields

| | Parameters | Sinechaadvin | Nagzor | Pernem | Katwal | Mopa |
|---|---|---|---|---|---|---|
| 1 | pH (20% slurry) | 7.10 | 7.12 | 6.90 | 8.25 | 7.32 |
| 2 | Conductivity (20% slurry), µmhos/cm | 158 | 182 | 169 | 172 | 185 |
| 3 | Texture | Sandy | Sandy | Sandy | Sandy | Sandy |
| 4 | Bulk Density, g/cm$^3$ | 1.69 | 1.52 | 1.64 | 1.51 | 1.63 |
| 5 | Infiltration, Cm/hr | 6.36 | 7.15 | 6.75 | 8.56 | 7.35 |
| 6 | Water Holding Capacity, % | 28.50 | 25.75 | 29.50 | 24.30 | 26.74 |
| 7 | Cation Exchange Capacity, Meq/100 gm | 1.23 | 1.10 | 1.15 | 1.10 | 1.20 |
| 8 | Sodium Absorption Ration (SAR)- | 8.52 | 8.85 | 8.74 | 7.10 | 7.95 |
| 9 | Porosity, % | 41.5 | 45.10 | 44.10 | 47.60 | 43.80 |
| 10 | Sodium, mg/100 gm | 20 | 24 | 20 | 17 | 23 |
| 11 | Potassium, mg/100 gm | 11.80 | 11.95 | 11.10 | 8.90 | 10.95 |
| 12 | Phosphate, mg/100 gm | 25 | 22 | 18 | 13 | 23 |
| 13 | Iron as Fe, mg/kg | 1.36 | 2.54 | 2.12 | 2.86 | 0.45 |
| 14 | Manganese, mg/kg | 7 | 6 | 8 | 5 | 6 |
| 15 | Lead, mg/kg | 0.05 | 0.05 | 0.09 | 0.06 | 0.04 |
| 16 | Copper, mg/kg | 2.0 | 1.0 | 3.0 | 2.0 | 3.0 |
| 17 | Chromium, mg/kg | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 18 | Cadmium, mg/kg | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

## 4.5 SOCIO-ECONOMIC ENVIRONMENT

The project site for the new Greenfield airport in the state of Goa is predominantly a tabletop plateau area surrounded by steep slopes with the proposed approach road to the new airport beginning from NH-17 at Dhargal village and passing through land in the villages of Ozorim, Varconda and Casarvornem. For this project an area of 2271 acres is required which inter alia requires properties acquired from six villages viz., Varconda, Casarvornem, Amberem, Uguem, Mopa and Chandel. The land in the project site is largely uncultivated with sparse vegetation and trees. The Government of Goa has negotiated for the purchase of land to be utilized for development of the airport and commercial facilities. Property acquisition is underway for the access road to the site for which the Rehabilitation & Relocation policy of the Goa State would be followed.

**Figure 4.6: Project Site**

**Baseline Information of the Project Site**

The Government of Goa has undertaken the development of the new Greenfield Airport at Goa, near the village Mopa which is located in North Goa close to the Maharashtra border. Mopa comes in Pernem tehsil of North Goa district and is approximately 35 kilometres north of Panaji, the Goa State Capital.

The North Goa District has an area of 1736 sq kms and shares its boundaries with Ratnagiri and Kolhapur districts of Maharashtra and South Goa district. As per the 2011 Census, the North Goa district had a population of 8,18,008 with 1,91,766 households. The languages spoken in the district are Konkani, Marathi, Hindi, English & Portuguese.

Demographic characteristics of the North Goa district based on the Census Data for the year 2011 are given below:

**Table 4.10: Population break-up of North Goa District**

| | Population | No. of Households | Male Population | Female Population |
|---|---|---|---|---|
| Total | 818008 | 191766 | 416677 | 401331 |
| Rural | 324927 | 74704 | 163908 | 161019 |
| Urban | 493081 | 117062 | 252769 | 240312 |

Source: 2011 Population Census of India

The detailed demographic profile including literates of the North Goa District as per 2011 Census is given below:

**Table 4.11: Demographic profile of North Goa district**

| Population | Total | Males | Females |
|---|---|---|---|
| Total | 816,008 | 416,677 | 401,331 |
| In the age group 0-6 years | 77,705 | 40,081 | 37,624 |
| Scheduled Castes (SC) | 17,606 | 8,712 | 8,894 |
| Scheduled Tribes (ST) | 56,606 | 27,824 | 28,782 |
| Literates | 663,060 | 351,738 | 311,322 |
| Illiterate | 154,948 | 64,939 | 90,009 |
| Total Workers | 327,658 | 239,125 | 88,533 |

Source: 2011 Population Census of India

The 2011 Census data shows that the percentages of Agricultural Labourers (main and marginal workers) and Cultivators (main and marginal workers) are just 3% and 4.35 % of the total working population of 3,27,658 persons. This indicates that a very small percentage of the total working population in the North Goa district engaged in agricultural activities.

**Demographic characteristics of Project Affected Villages:**

As mentioned earlier, the project site comprises of land acquired from six villages viz., Varconda, Casarvornem, Amberem, Uguem, Mopa and Chandel. The demographic profile of the six villages is given below:

**Table 4.12 : Demographic profile of villages in project site**

| Villages | No. of Households | Population | Scheduled Caste |
|---|---|---|---|
| Varconda | 507 | 2208 | 71 |
| Amberem | 75 | 341 | 0 |
| Uguem | 234 | 1133 | 61 |
| Mopa | 243 | 1082 | 68 |
| Chandel | 272 | 1152 | 35 |
| Cansarvornem | 310 | 1382 | 33 |
| TOTAL | 1641 | 7298 | 268 |
| % | | 100 | 3.67 |

Source: 2011 Population Census of India

The total population of the six villages in the study area is 7298 living in 1641 households. When compared to the overall population in the North Goa district , these six villages form just around 1 % of the total district's population. The percentage of population belonging to

the Scheduled Caste is only 3.67% of the total population in the study area, while there are no persons belonging to the Scheduled Tribes in this area.

**Literacy Rates In Froject Affected Villages:**

The total number of literates in the six villages comprising the study area is 5507 which is 75.45% of the total population of the study area. The break-up of literacy rates for male and female populations in the six villages in the study area is given below:

**Table 4.13: Literacy rates of project affected villages**

| Villages | Literates | Illiterates |
|---|---|---|
| Varconda | 1707 | 501 |
| Amberem | 234 | 107 |
| Uguem | 924 | 209 |
| Mopa | 836 | 246 |
| Chandel | 775 | 377 |
| Cansarvornem | 1031 | 351 |
| TOTAL | 5507 | 1791 |

Source: 2011 Population Census of India

The above table 4.13 shows that the literate population in the project affected villages is less than one per cent of the North Goa district's literate population. However, the literacy rate in the study area is 75. 5%.

**Table 4.14: Public Amenities In North Goa District**

| Public amenities | No. of units |
|---|---|
| Post Offices | 162 |
| Govt Hospital | 5 |
| Rural Medical Dispensaries | 19 |
| Private Hospitals | 75 |
| Community Health Centres | 3 |
| Primary Health Centres | 11 |

The health facilities in North Goa District include five Government Hospitals, 19 rural medical dispensaries, 75 private hospitals, 11 Primary Health Centres and 3 Community Health centres, as per the Goa Statistical Handbook of 2008-09.

## 4.6 BIOLOGICAL ENVIRONMENT

Ecological studies are one of the important aspects of Environmental Impact Assessment with a view to conserve environmental quality and biodiversity. Ecological systems show complex inter-relationships between biotic and abiotic components including dependence, competition and mutualism. Biotic components comprise of both plant and animal communities, which interact not only within and between themselves but also with the abiotic components viz. physical and chemical components of the environment.

Generally, biological communities are good indicators of climatic and edaphic factors. Studies on biological aspects of ecosystems are important in Environmental Impact

Assessment for safety of natural flora and fauna. The biological environment includes terrestrial and aquatic ecosystems.

The animal and plant communities co-exist in a well-organized manner. Their natural settings can get disturbed by any externally induced anthropological activities or by naturally occurring calamities or disaster. So, once this setting is disturbed, it sometimes is either practically impossible or may take a longer time to come back to its original state. Hence changes in the status of flora and fauna are an elementary requirement of Environmental Impact Assessment studies, in view of the need for conservation of environmental quality and biodiversity. Information on flora and fauna was collected within the study area.

**Objectives of Ecological Studies**

The objective of the present study was undertaken with a view to understand the present ecosystem on the following lines:

- To assess the distribution of vegetation in and around the proposed airport site;
- To assess the distribution of animal life in the proposed plant areas as well as surrounding areas;
- To assess the biodiversity and to understand the resource potential; and
- To understand the nature of poliution and the impact of pollution on the ecosystem.

**Methodology Adopted for the Survey**

To achieve above objectives a detailed study of the area was undertaken in 10-km radius area with the proposed project site as its centre. The different methods adopted were as follows:

* Compilation of secondary data with respect to the study area from published literature and Government agencies;
* Generation of first hand data by undertaking systematic ecological studies in the area;
* Interrogating local people so as to elicit information for local plants, animals and their uses

The present report gives the review of published secondary data and the results of field sampling conducted during winter season 2013.

**Methodology – Flora & Fauna**

**Floral diversity**

The study was aimed at enumeration of the available plant resources and obtaining a broad representation of the existing floristic variations in and around the proposed project site. The site was surveyed through random sampling and the floristic diversity was enumerated. All floral elements encountered in the field were photographed. All the species encountered were identified with the help of local authenticate published flora.

**Faunal diversity**

Random walk and opportunistic observations were used for documenting the birds. With the aid of a pair of binoculars the bird sampling were carried out during morning (06:00 to 10:00 hrs) and evening (17:00 to 19:00 hrs) hours. Point count methods were used for enumerating the avifauna in mudflat areas. Birds were monitored by road transects up to 200 metres distance to obtain information on population. Data on fishes were collected from secondary sources and interview with fishor folk of the area. During the present study period, both direct and indirect methods (tracks & signs and visual encounter survey) were

used to document the mammals occurring in the area. Visual Encounter Survey (VES) method was followed for the survey of the herpetofauna (amphibians and reptiles) in the study area during the present study. VES is a method one in which field personnel walk through an area or habitat for a prescribed time period systematically searching for animals.

**Floral diversity**

The area falling under the 10 km radial distance is surrounded by both aquatic and terrestrial ecosystems. Diverse systems such as dense and open forest, cultivated lands, sand dune vegetation, wetlands and human habitation were present in the study area that supported diverse floral species.

A total of 385 species of plants (including wild, ornamental and cultivated plants) belonging 88 plant families were documented and identified in the 10 km radial distance from the proposed project sites of the study area. The identified plant species with scientific name, family, habit, habitat and type are given in Table 4.15

**Table 4.15 Distribution of plants in the study area and its surrounding**

| Sl. No. | Plant Name | Family | Habit | Habitat | Type |
|---|---|---|---|---|---|
| 1 | Abelmoschus manihot (L.) Medic. | Malvaceae | Herb | Terrestrial | Wiid |
| 2 | *Abrus precatorius* L. | Fabaceae | Straggler | Terrestrial | Wiid |
| 3 | *Abutilon indicum* (L.) Sweet | Malvaceae | Shrub | Terrestrial | Wild |
| 4 | *Acacia auriculiformis* A. Cunn ex Benth. | Fabaceae | Tree | Terrestrial | Exotic |
| 5 | Acacia catechu (L. f.) Willd. | Mimosaceae | Tree | Terrestrial | Wild |
| 6 | Acacia chundra (Rottl.) Willd. | Mimosaceae | Tree | Terrestrial | Wild |
| 7 | *Acacia leucophloea* (Roxb.) Wiild. | Fabaceae | Tree | Terrestrial | Wild |
| 8 | Acacia pennata (L.) Willd. | Mimosaceae | Tree | Terrestrial | Wild |
| 9 | *Acalypha indica* L. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 10 | *Acanthospermum hispidum* DC. | Asteraceae | Herb | Terrestrial | Wild |
| 11 | *Achras zapota* Linn. | Sapotaceae | Tree | Terrestrial | Cultivated |
| 12 | *Achyranthes aspera* L. | Amaranthaceae | Herb | Terrestrial | Wild |
| 13 | *Aegle marmelos* (L.) Correa | Rutaceae | Tree | Terrestrial | Wild |
| 14 | *Aeluropus lagopoides* (Linn.) Trin. ex Thw. | Poaceae | Grass | Semi-aquatic | Wild |
| 15 | *Aeschynomene indica* L. | Fabaceae | Herb | Terrestrial | Wild |
| 16 | *Allanthus excelsa* Roxb. | Simaroubaceae | Tree | Terrestrial | Wild |
| 17 | *Alangium salviifolium* (L.f.) Wang. | Alangiaceae | Tree | Terrestrial | Wild |
| 18 | *Albizia lebbeck* (L.) Wiild. | Fabaceae | Tree | Terrestrial | Wild |
| 19 | *Alstonia scholaris* (L.) R.Br. | Apocynaceae | Tree | Terrestrial | Cultivated |
| 20 | *Alternanthera paronychioides* A. St.-Hilaire | Amaranthaceae | Herb | Terrestrial | Wild |
| 21 | *Alternanthera pungens* Kunth | Amaranthaceae | Herb | Terrestrial | Wild |
| 22 | *Alternanthera sessilis* (L.) R.Br. ex DC. | Amaranthaceae | Herb | Aquatic | Wild |

| | | | | | |
|---|---|---|---|---|---|
| 23 | *Alternanthera tenella* Colla. | Amaranthaceae | Herb | Semi-aquatic | Wild |
| 24 | *Alysicarpus monilifer* (L.) DC. | Fabaceae | Herb | Terrestrial | Wild |
| 25 | Alysicarpus vaginalis (L.) DC. | Fabaceae | Herb | Terrestrial | Wild |
| 26 | *Amaranthus spinosus* L. | Amaranthaceae | Herb | Terrestrial | Wild |
| 27 | *Amaranthus viridis* L. | Amaranthaceae | Herb | Terrestrial | Wild |
| 28 | *Ammannia baccifera* Linn. | Lythraceae | Herb | Semi-aquatic | Wild |
| 29 | *Anacardium occidentale* L. | Anacardiaceae | Tree | Terrestrial | Planted |
| 30 | *Andropogon pumilus* Roxb. | Poaceae | Grass | Terrestrial | Wild |
| 31 | *Anisomeles indica* (L.) Kuntze | Lamiaceae | Herb | Terrestrial | Wild |
| 32 | *Annona squamosa* L. | Annonaceae | Tree | Terrestrial | Cultivated |
| 33 | *Anthocephalus cadamba* (Roxb.) Miq. | Rubiaceae | Tree | Terrestrial | Cultivated |
| 34 | *Argemone mexicana* L. | Papaveraceae | Herb | Terrestrial | Exotic |
| 35 | *Aristida adscensionis* L. | Poaceae | Grass | Terrestrial | Wild |
| 36 | *Aristida funiculata* Trin & Rupr. | Poaceae | Grass | Terrestrial | Wild |
| 37 | *Aristida hystrix* L. | Poaceae | Grass | Terrestrial | Wild |
| 38 | *Aristida setacea* Retz. | Poaceae | Grass | Terrestrial | Wild |
| 39 | *Aristolochia indica* L. | Aristolochiaceae | Climber | Terrestrial | Wild |
| 40 | Artabotrys hexapetalus (L.f.) | Annonaceae | Tree | Terrestrial | Cultivated |
| 41 | *Asparagus racemosus* Willd. | Asparagaceae | Straggler | Terrestrial | Wild |
| 42 | *Avicennia marina* (Forsk.) Vierh. | Acanthaceae | Tree | Semi-aquatic | Wild |
| 43 | *Azadirachta indica* A. Juss. | Meliaceae | Tree | Terrestrial | Wild |
| 44 | *Bambusa arundinacea* (Retz.) Willd. | Poaceae | Grass | Terrestrial | Wild |
| 45 | *Bambusa vulgaris* Schrad. ex Wendl. | Poaceae | Grass | Terrestrial | Ornamental |
| 46 | *Barleria buxifolia* L. | Acanthaceae | Herb | Terrestrial | Wild |
| 47 | *Barleria prionitis* L. | Acanthaceae | Herb | Terrestrial | Wild |
| 48 | *Bassia latifolia* Roxb. | Sapotaceae | Tree | Terrestrial | Wild |
| 49 | *Bauhinia purpurea* L. | Fabaceae | Tree | Terrestrial | Cultivated |
| 50 | *Bauhinia racemosa* Lam. | Fabaceae | Tree | Terrestrial | Wild |
| 51 | *Bidens pilosa* L. | Asteraceae | Herb | Terrestrial | Wild |
| 52 | Biophytum candolleanum Wt. | Oxalidaceae | Herb | Terrestrial | Wild |
| 53 | *Blainvillea acmella* (L.) Philipson | Asteraceae | Herb | Terrestrial | Wild |
| 54 | *Blepharis maderaspatensis* (L.) Heyne ex Roth | Acanthaceae | Herb | Terrestrial | Wild |
| 55 | *Blepharis repens* (Vahl) Roth | Acanthaceae | Herb | Terrestrial | Wild |
| 56 | *Blumea lacera* (Burm.f) DC. | Asteraceae | Herb | Terrestrial | Wild |
| 57 | *Blumea mollis* (D.Don) Merr. | Asteraceae | Herb | Terrestrial | Wild |
| 58 | *Boerhavia diffusa* L. | Nyctaginaceae | Herb | Terrestrial | Wild |
| 59 | *Boerhavia erecta* L. | Nyctaginaceae | Herb | Terrestrial | Wild |
| 60 | *Bombax ceiba* L. | Bombacaceae | Tree | Terrestrial | Wild |
| 61 | *Borassus flabellifer* L. | Arecaceae | Tree | Terrestrial | Wild |

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|---|---|---|---|---|---|
| 62 | *Bothriochloa pertusa* (L.) A. Camus | Poaceae | Grass | Terrestrial | Wild |
| 63 | *Bougainvillea spectabilis* Comm. ex. Juss. | Nyctaginaceae | Straggler | Terrestrial | Ornamental |
| 64 | *Breynia retusa* (Dennst.) Alston | Euphorbiaceae | Shrub | Terrestrial | Wild |
| 65 | *Buchanania lanzan* Spreng. | Anacardiaceae | Tree | Terrestrial | Wild |
| 66 | *Bulbostylis barbata* (Rottb.) C.B. Clarke | Cyperaceae | Herb | Terrestrial | Wild |
| 67 | *Butea monosperma* (Lam.) Taub. | Fabaceae | Tree | Terrestrial | Wild |
| 68 | *Caesalpinia crista* L. | Caesalpiniaceae | Climber | Terrestrial | Wild |
| 69 | *Cajanus cajan* (L.) Huth | Fabaceae | Shrub | Terrestrial | Cultivated |
| 70 | *Callophyllum inophyllum* L. | Clusiaceae | Tree | Terrestrial | Wild |
| 71 | *Calotropis procera* (Ait.) R.Br. | Apocynaceae | Shrub | Terrestrial | Wild |
| 72 | *Calycopteris floribunda* Lam. | Combretaceae | Climber | Terrestrial | Wild |
| 73 | *Canavalia cathartica* Thouars | Fabaceae | Straggler | Terrestrial | Wild |
| 74 | *Capparis sepiaria* L. | Capparidaceae | Straggler | Terrestrial | Wild |
| 75 | *Capparis zeylanica* L. | Capparidaceae | Straggler | Terrestrial | Wild |
| 76 | *Capsicum annum* L. | Solanaceae | Shrub | Terrestrial | Cultivated |
| 77 | Carallia brachiata (Lour) Merr. | Rhizophoraceae | Tree | Aquatic | Wild |
| 78 | *Cardiospermum halicacabum* L. | Sapindaceae | Climber | Terrestrial | Wild |
| 79 | *Careya arborea* Roxb. | Barringtoniaceae | Tree | Terrestrial | Wild |
| 80 | Careya arborea Roxb. | Barringtoniaceae | Tree | Terrestrial | Wild |
| 81 | *Carica papaya* L. | Caricaceae | Tree | Terrestrial | Cultivated |
| 82 | *Caryota urens* L. | Arecaceae | Tree | Terrestrial | Wild |
| 83 | Casearia elliptica Willd..(C. tomentosa Willd..) | Flacourtiaceae | Tree | Terrestrial | Wild |
| 84 | *Cassia fistula* L. | Fabaceae | Tree | Terrestrial | Wild |
| 85 | *Cassia occidentalis* L. | Caesalpiniaceae | Herb | Terrestrial | Wild |
| 86 | *Cassia siamea* Lam. | Fabaceae | Tree | Terrestrial | Wild |
| 87 | *Cassia tora* L. | Caesalpiniaceae | Herb | Terrestrial | Wild |
| 88 | *Casuarina equisetifolia* L. | Casurinaceae | Tree | Terrestrial | Planted |
| 89 | *Cayratia elongata* (Roxb.) Susseng. | Vitaceae | Climber | Terrestrial | Wild |
| 90 | *Ceiba pentandra* (L.) Gaertn. | Bombacaceae | Tree | Terrestrial | Wild |
| 91 | *Celastrus paniculata* Willd. | Celastraceae | Shrub | Terrestrial | Wild |
| 92 | *Celosia argentea* L. | Amaranthaceae | Herb | Terrestrial | Wild |
| 93 | *Cenchrus ciliaris* L. | Poaceae | Grass | Terrestrial | Wild |
| 94 | Cereus pterogonus Lem. | Cactaceae | Herb | Terrestrial | Wild |
| 95 | *Chloris barbata* Sw. | Poaceae | Grass | Terrestrial | Wild |
| 96 | *Chloris dolichostachya* Lagasca | Poaceae | Grass | Terrestrial | Wild |
| 97 | *Chloris tenella* Koen. ex Rcxb. | Poaceae | Grass | Terrestrial | Wild |
| 98 | *Chromolaena odorata* (L.) King & Robinson | Asteraceae | Shrub | Terrestrial | Exotic |
| 99 | *Cissampelos pareira* L. | Menispermaceae | Climber | Terrestrial | Wild |
| 100 | *Cleome monophylla* L. | Capparaceae | Herb | Terrestrial | Wild |

| | | | | | |
|---|---|---|---|---|---|
| 101 | *Cleome viscosa* L. | Capparidaceae | Herb | Terrestrial | Wild |
| 102 | *Clitoria ternatea* L. | Fabaceae | Climber | Terrestrial | Wild |
| 103 | *Coccinia grandis* (L.) Voigt | Cucurbitaceae | Climber | Terrestrial | Wild |
| 104 | *Cocculus hirsutus* (L.) Diels | Menispermaceae | Climber | Terrestrial | Wild |
| 105 | *Cocculus pendulus* (Forst.) Diels | Menispermaceae | Straggler | Terrestrial | Wild |
| 106 | *Cocos nucifera* L. | Arecaceae | Tree | Terrestrial | Cultivated |
| 107 | *Colubrina asiatica* (L.) Brongn. | Rhamnaceae | Shrub | Terrestrial | Wild |
| 108 | *Combretum albidum* G.Don | Combretaceae | Climber | Terrestrial | Wild |
| 109 | *Commelina benghalensis* L. | Commelinaceae | Herb | Terrestrial | Wild |
| 110 | *Commelina clavata* Clarke | Commelinaceae | Herb | Terrestrial | Wild |
| 111 | *Commelina longifolia* Lam. | Commelinaceae | Herb | Terrestrial | Wild |
| 112 | *Convolvulus arvensis* L. | Convolvulaceae | Climber | Terrestrial | Wild |
| 113 | *Corchorus aestuans* L. | Tiliaceae | Herb | Terrestrial | Wild |
| 114 | *Corchorus trilocularis* L. | Tiliaceae | Herb | Terrestrial | Wild |
| 115 | *Cordia dichotoma* G. Forst. | Boraginaceae | Tree | Terrestrial | Wild |
| 116 | *Cordia myxa* L. | Boraginaceae | Tree | Terrestrial | Wild |
| 117 | *Cordia sebestena* L. | Boraginaceae | Tree | Terrestrial | Ornamental |
| 118 | *Crotalaria juncea* L. | Papilionaceae | Shrub | Terrestrial | Wild |
| 119 | *Crotalaria mucronata* Desv. | Fabaceae | Herb | Terrestrial | Wild |
| 120 | *Crotalaria pallida* Dryand. var. *pallida*(G.Don) Polhill | Fabaceae | Herb | Terrestrial | Wild |
| 121 | *Croton bonplandianum* Baill. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 122 | *Cryptolepis buchananii* Roem. & Schult. | Asclepiadaceae | Straggler | Terrestrial | Wild |
| 123 | *Cucumis melo* L. | Cucurbitaceae | Climber | Terrestrial | Wild |
| 124 | *Cuminum cyminum* L. | Apiaceae | Shrub | Terrestrial | Cultivated |
| 125 | *Curculigo orchioides* Gaertn. | Hypoxidaceae | Herb | Terrestrial | Wild |
| 126 | *Cuscuta reflexa* Roxb. | Convolvulaceae | Climber | Terrestrial | Wild |
| 127 | *Cyclea peltata (Lamk.) Hook.f. & Thoms.* | Annonaceae | Climber | Terrestrial | Wild |
| 128 | *Cynodon dactylon* (L.) Pers. | Poaceae | Grass | Terrestrial | Wild |
| 129 | *Cynoglossum zeylanicum* (Vahl ex Hornem.) Thunb. ex Lehm. | Boraginaceae | Herb | Terrestrial | Wild |
| 130 | *Cyperus articulatus* L. | Cyperaceae | Herb | Aquatic | Wild |
| 131 | *Cyperus difformis* L. | Cyperaceae | Herb | Semi-aquatic | Wild |
| 132 | *Cyperus exaltatus* Retz. | Cyperaceae | Herb | Aquatic | Wild |
| 133 | *Cyperus iria* L. | Cyperaceae | Herb | Semi-aquatic | Wild |
| 134 | *Cyperus rotundus* L. | Cyperaceae | Herb | Terrestrial | Wild |
| 135 | *Dactyloctenium aegyptium* (L.) Willd. | Poaceae | Grass | Terrestrial | Wild |
| 136 | *Dalbergia sissoo* Roxb. | Fabaceae | Tree | Terrestrial | Planted |
| 137 | *Datura metal* L. | Solanaceae | Shrub | Terrestrial | Wild |
| 138 | *Delonix elata* (L.) Gamble | Fabaceae | Tree | Terrestrial | Wild |

| | | | | | |
|---|---|---|---|---|---|
| 139 | *Delonix regia* (Boj. ex Hook) Rafin. | Fabaceae | Tree | Terrestrial | Wild |
| 140 | *Derris scandens* (Roxb.) Benth. | Fabaceae | Climber | Semi-aquatic | Wild |
| 141 | *Derris scandens* (Roxb.) Benth. | Fabaceae | Shrub | Terrestrial | Wild |
| 142 | *Derris trifoliata* Lour. | Fabaceae | Climber | Semi-aquatic | Wild |
| 143 | *Desmodium laxiflorum* DC. | Fabaceae | Shrub | Terrestrial | Wild |
| 144 | Desmodium triangulare (Retz.) Merr. | Fabaceae | Shrub | Terrestrial | Wiid |
| 145 | *Dichrostachys cinerea* (L.) Wight & Arn. | Fabaceae | Shrub | Terrestrial | Wild |
| 146 | *Dicoma tomentosa* Cass. | Asteraceae | Herb | Terrestrial | Wiid |
| 147 | *Digera muricata* (L.) Mart. | Amaranthaceae | Herb | Terrestrial | Wild |
| 148 | *Dillenia indica* L. | Dilleniaceae | Tree | Terrestrial | Wild |
| 149 | *Dillenia pentagyna* Roxb. | Dilleniaceae | Tree | Terrestrial | Wild |
| 150 | *Diospyros montana* Roxb. | Ebenaceae | Tree | Terrestrial | Wild |
| 151 | *Diplocyclos palmatus* (L.) Jeffrey | Cucurbitaceae | Climber | Terrestrial | Wild |
| 152 | *Dolichandrone spathacea* (L.f.) K.Schum. | Bignoniaceae | Tree | Terrestrial | Planted |
| 153 | *Dolichos lablab* L. | Fabaceae | Climber | Terrestrial | Cultivated |
| 154 | *Drosera indica* L. | Droseraceae | Herb | Aquatic | Wild |
| 155 | *Echinochloa colona* (L.) Link | Poaceae | Grass | Semi-aquatic | Wild |
| 156 | *Echinops echinatus* Roxb. | Asteraceae | Herb | Terrestrial | Wild |
| 157 | *Eclipta prostrata* (L.) L. | Asteraceae | Herb | Semi-aquatic | Wild |
| 158 | *Elaeocarpus serratus* L. | Tiliaceae | Tree | Terrestrial | Wild |
| 159 | *Embllia ribes* Burm.f. | Mysinaceae | Shrub | Terrestrial | Wild |
| 160 | *Emilia sonchifolia* (L.) DC. | Asteraceae | Herb | Terrestrial | Wild |
| 161 | *Eragrostis nutans* (Retz.) Nees ex Steud. | Poaceae | Grass | Terrestrial | Wild |
| 162 | *Eragrostis pilosa* P. Beauv | Poaceae | Grass | Terrestrial | Wild |
| 163 | *Eragrostis unioloides* (Retz.) Nees ex Steud. | Poaceae | Grass | Terrestrial | Wild |
| 164 | *Eragrostis viscosa* (Retz.) Trin. | Poaceae | Grass | Terrestrial | Wild |
| 165 | *Erythrina stricta* Roxb. | Fabaceae | Tree | Terrestrial | Planted |
| 166 | *Eucalyptus teriticornis* | Myrtaceae | Tree | Terrestrial | Planted |
| 167 | *Euphorbia geniculata* Ortega | Euphorbiaceae | Herb | Terrestrial | Wild |
| 168 | *Euphorbia hirta* L. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 169 | *Euphorbia nivulia* L. | Euphorbiaceae | Shrub | Terrestrial | Wild |
| 170 | *Euphorbia rosea* Retz. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 171 | *Euphorbia thymifolia* L. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 172 | *Euphorbia tirucalli* L. | Euphorbiaceae | Tree | Terrestrial | Wild |
| 173 | *Evolvulus alsinoides* (L.) L. | Convolvulaceae | Herb | Terrestrial | Wild |
| 174 | *Evolvulus nummularius* (L.) L. | Convolvulaceae | Herb | Terrestrial | Wild |
| 175 | *Ficus arnottiana* Miq. | Moraceae | Tree | Terrestrial | Wild |

| | | | | | |
|---|---|---|---|---|---|
| 176 | *Ficus benghalensis* L. | Moraceae | Tree | Terrestrial | Wild |
| 177 | *Ficus microcarpa* var. *microcarpa* L.f. | Moraceae | Tree | Terrestrial | Wild |
| 178 | *Ficus racemosa* L. | Moraceae | Tree | Terrestrial | Wild |
| 179 | *Ficus religiosa* L. | Moraceae | Tree | Terrestrial | Wild |
| 180 | *Filicium decipiens* (Wight & Arn.) Thw. | Sapindaceae | Tree | Terrestrial | Wild |
| 181 | *Fimbristylis aestivalis* (Retz.) Vahl. | Cyperaceae | Herb | Terrestrial | Wild |
| 182 | *Fimbristylis argentea* (Rottb.) Vahl. | Cyperaceae | Herb | Aquatic | Wild |
| 183 | *Fimbristylis dichotoma* (L.) Vahl. | Cyperaceae | Herb | Semi-aquatic | Wild |
| 184 | *Fimbristylis ovata* (Burm. F.) Kern. | Cyperaceae | Herb | Terrestrial | Wild |
| 185 | *Firmiana colorata* (Roxb.) R.Br.(Sterculia colorata Roxb.)) | Sterculiaceae | Tree | Terrestrial | Wild |
| 186 | *Flacourtia indica* (Burm.f.) Merr. | Flacourtiaceae | Tree | Terrestrial | Wild |
| 187 | *Foeniculum vulgare* Mill. | Apiaceae | Herb | Terrestrial | Wild |
| 188 | *Garuga pinnata* Roxb. | Burseraceae | Tree | Terrestrial | Wild |
| 189 | *Glinus lotoides* Linnaeus | Aizoaceae | Herb | Aquatic | Wild |
| 190 | *Gliricidia sepium* (Jacq.) Kunth ex Walp. | Fabaceae | Tree | Terrestrial | Exotic |
| 191 | *Gloriosa superba* L. | Colchicaceae | Herb | Terrestrial | Wild |
| 192 | *Gmelina arborea* Roxb. | Verbenaceae | Tree | Terrestrial | Wild |
| 193 | *Gomphrena serrata* L. | Amaranthaceae | Herb | Terrestrial | Wild |
| 194 | *Goniogyna hirta* (Willd.) Ali | Fabaceae | Herb | Terrestrial | Wild |
| 195 | *Grewia tiliaefolia* Vahl. | Tiliaceae | Tree | Terrestrial | Wild |
| 196 | *Gymnema sylvestre* (Retz.) R.Br. ex Schult. | Asclepiadaceae | Climber | Terrestrial | Wild |
| 197 | *Haldinia cordifolia* (Roxb.) Ridsd. | Rubiaceae | Tree | Terrestrial | Wild |
| 198 | *Hedyotis biflora* (L.) Lam. | Rubiaceae | Herb | Terrestrial | Wild |
| 199 | *Hedyotis corymbosa* (L.) Lam. | Rubiaceae | Herb | Terrestrial | Wild |
| 200 | *Helicteres isora* L. | Sterculiaceae | Shrub | Terrestrial | Wild |
| 201 | *Heliotropium curasavicum* L. | Boraginaceae | Herb | Terrestrial | Wild |
| 202 | *Hemidesmus indicus* (L.) R. Br. | Asclepiadaceae | Climber | Terrestrial | Wild |
| 203 | *Heteropogon contortus* (L.) P.Beauv | Poaceae | Grass | Terrestrial | Wild |
| 204 | *Hibiscus rosa-sinensis* L. | Malvaceae | Shrub | Terrestrial | Cultivated |
| 205 | *Hibiscus tiliaceus* L. | Malvaceae | Tree | Terrestrial | Planted |
| 206 | *Hibiscus vitifolius* L. | Malvaceae | Shrub | Terrestrial | Wild |
| 207 | *Holarrhena pubescens* (Buch.-Ham.) Wall. ex G.Don | Apocynaceae | Shrub | Terrestrial | Wild |
| 208 | *Holigarna arnottiana* Hook.f. | Anacardiaceae | Tree | Terrestrial | Wild |
| 209 | *Holoptelea integrifolia* (Roxb.) Planch. | Ulmaceae | Tree | Terrestrial | Planted |

| | | | | | |
|---|---|---|---|---|---|
| 210 | *Hydnocarpus laurifolia* (Dennst.) Sleumer | Flacourtiaceae | Tree | Terrestrial | Wild |
| 211 | *Hyptis suaveolens* (L.) Poit. | Lamiaceae | Herb | Terrestrial | Wild |
| 212 | *Ichnocarpus frutescens* (L.) R.Br. | Asclepiadaceae | Climber | Terrestrial | Wild |
| 213 | *Impatiens inconspicua* Benth. Ex Wt. & Arn. | Balsaminaceae | Herb | Terrestrial | Wild |
| 214 | *Imperata cylindrica (L.) Beauv.* | Poaceae | Grass | Terrestrial | Wild |
| 215 | *Indigofera linifolia* (L.f.) Retz. | Fabaceae | Herb | Terrestrial | Wild |
| 216 | *Indigofera linnaei* Ali | Fabaceae | Herb | Terrestrial | Wild |
| 217 | *Indoneesiella echioides* (L) Nees. | Acanthaceae | Herb | Terrestrial | Wild |
| 218 | *Ipomoea alba* L. | Convolvulaceae | Climber | Terrestrial | Wild |
| 219 | *Ipomoea aquatica* Forssk. | Convolvulaceae | Climber | Aquatic | Wild |
| 220 | *Ipomoea carnea* Jacq. | Convolvulaceae | Shrub | Aquatic | Wild |
| 221 | *Ipomoea hederifolia* L. | Convolvulaceae | Climber | Terrestrial | Wild |
| 222 | *Ipomoea pes-tigridis* L. | Convolvulaceae | Climber | Terrestrial | Wild |
| 223 | *Ipomoea pres-caprae*(L.) R.Br. | Convolvulaceae | Climber | Terrestrial | Wild |
| 224 | *Ipomoea quamoclit* L. | Convolvulaceae | Climber | Terrestrial | Ornamental |
| 225 | *Ipomoea staphylina* Roem. & Schuites | Convolvulaceae | Climber | Terrestrial | Wild |
| 226 | *Ischaemum indicum* (Houtt.) Merr. | Poaceae | Grass | Terrestrial | Wild |
| 227 | *Ixora arborea* Roxb. ex Sm. | Rubiaceae | Tree | Terrestrial | Wild |
| 228 | *Ixora coccinea* | Rubiaceae | Shrub | Terrestrial | Wild |
| 229 | *Jasminum scandens* Vahl | Oleaceae | Climber | Terrestrial | Wild |
| 230 | *Jatropha curcas* L. | Euphorbiaceae | Shrub | Terrestrial | Planted |
| 231 | *Jatropha gossypifolia* L. | Euphorbiaceae | Shrub | Terrestrial | Wild |
| 232 | *Justicia adhatoda* L. | Acanthaceae | Shrub | Terrestrial | Ornamental |
| 233 | *Justicia betonica* Linn. | Acanthaceae | Shrub | Terrestrial | Wild |
| 234 | *Kydia calycina* Roxb. | Malvaceae | Tree | Terrestrial | Wild |
| 235 | *Lagascea mollis* Cav. | Asteraceae | Herb | Terrestrial | Wild |
| 236 | *Lagerstroemia microcarpa* Hance | Lythraceae | Tree | Terrestrial | Wild |
| 237 | *Lannea coromandelica* (Houtt.) Merr. | Anacardiaceae | Tree | Terrestrial | Wild |
| 238 | *Lantana camara* L. | Verbenaceae | Shrub | Terrestrial | Exotic |
| 239 | *Launaea sarmentosa* (Willd.) Schultz-Bip.ex Kuntze | Asteraceae | Climber | Terrestrial | Wild |
| 240 | *Lawsonia inermis* L. | Lythraceae | Shrub | Terrestrial | Planted |
| 241 | *Leea indica* (Burm.f) Merr. | Vitaceae | Shrub | Terrestrial | Wild |
| 242 | *Leea indica* (Burm.f) Merr. | Vitaceae | Shrub | Terrestrial | Wild |
| 243 | *Leptadenia reticulata* Wight & Arn. | Asclepiadaceae | Climber | Terrestrial | Wild |
| 244 | *Leucaena leucocephala* (L.) Gills | Fabaceae | Tree | Terrestrial | Exotic |
| 245 | *Leucas aspera* (Willd.) Link | Lamiaceae | Herb | Terrestrial | Wild |
| 246 | *Limonia acidissima* L. | Rutaceae | Tree | Terrestrial | Cultivated |

| | | | | | |
|---|---|---|---|---|---|
| 247 | *Ludwigia adscendens* (L.) Hara | Onagraceae | Herb | Aquatic | Wild |
| 248 | *Ludwigia perennis* L. | Onagraceae | Herb | Semi-aquatic | Wild |
| 249 | *Ludwigia peruviana* (L.) Hara | Onagraceae | Herb | Semi-aquatic | Wild |
| 250 | *Luffa acutangula* (L.) Roxb. | Cucurbitaceae | Climber | Terrestrial | Cultivated |
| 251 | *Macaranga peltata* (Roxb.) Muell.-Arg. | Euphorbiaceae | Tree | Terrestrial | Wild |
| 252 | *Malachra capitata* (L.) L.syst | Malvaceae | Herb | Terrestrial | Wild |
| 253 | *Malvastrum coromandelianum* (L.) Garcke | Malvaceae | Herb | Terrestrial | Wild |
| 254 | *Mangifera indica* L. | Anacardiaceae | Tree | Terrestrial | Planted |
| 255 | *Maytenus emarginata* (Willd.) Ding Hou | Celastraceae | Shrub | Terrestrial | Wild |
| 256 | *Melastoma malabathricum* L. | Melastomataceae | Shrub | Terrestrial | Wild |
| 257 | *Melochia corchorifolia* L. | Sterculiaceae | Herb | Terrestrial | Wild |
| 258 | *Memecylon umbellatum*Burm.f. | Melastomaceae | Tree | Terrestrial | Wild |
| 259 | *Merremia tridentata* (L.) Hall.f. | Convolvulaceae | Herb | Terrestrial | Wild |
| 260 | *Microcos paniculatus* L. | Tiliaceae | Tree | Terrestrial | Wild |
| 261 | *Millingtonia hortensis* L.f. | Bignoniaceae | Tree | Terrestrial | Ornamental |
| 262 | *Mimosa hamata* Willd. | Fabaceae | Shrub | Terrestrial | Wild |
| 263 | *Mimusops elengi* L. | Sapotaceae | Tree | Terrestrial | Ornamental |
| 264 | *Mitragyna parvifolia* (Roxb.) Korth. | Rubiaceae | Tree | Terrestrial | Wild |
| 265 | *Mollugo pentaphylla* L. | Molluginaceae | Herb | Aquatic | Wild |
| 266 | *Momordica charantia* L. | Cucurbitaceae | Climber | Terrestrial | Wild |
| 267 | *Moringa oleifera* Lam. | Moringaceae | Tree | Terrestrial | Cultivated |
| 268 | *Moullava spicata* (Dalzell) Nicolson | Fabaceae | Climber | Terrestrial | Wild |
| 269 | *Mucuna prurita* Hook. | Fabaceae | Climber | Terrestrial | Wild |
| 270 | *Mukia maderaspatana* (L.) M. Roem. | Cucurbitaceae | Climber | Terrestrial | Wild |
| 271 | *Murraya koenigii* (L.) Spreng. | Rutaceae | Tree | Terrestrial | Planted |
| 272 | *Musa paradisiaca* L. | Musaceae | Shrub | Terrestrial | Cultivated |
| 273 | *Nepuntia oleracea* Lour. | Mimosaceae | Herb | Aquatic | Wild |
| 274 | *Nyctanthes arbor-tristis* L. | Oleaceae | Tree | Terrestrial | Ornamental |
| 275 | *Nymphaea nouchali* Burm.f. | Nymphaeaceae | Herb | Aquatic | Wild |
| 276 | *Nymphaea pubescens* Willd. | Nymphaeaceae | Herb | Aquatic | Wild |
| 277 | *Ocimum canum* Sims. | Lamiaceae | Herb | Terrestrial | Wild |
| 278 | *Oldenlandia umbellata* L. | Rubiaceae | Herb | Terrestrial | Wild |
| 279 | *Opuntia stricta* (Haw.) Haw. | Cactaceae | Shrub | Terrestrial | Wild |
| 280 | *Parthenium hysterophorus* L. | Asteraceae | Herb | Terrestrial | Exotic |
| 281 | *Pavonia odorata* Willd. | Malvaceae | Herb | Terrestrial | Wild |
| 282 | *Pavonia procumbens* (Wall ex Wight & Arn.) Walp. | Malvaceae | Herb | Terrestrial | Wild |

| | | | | | |
|---|---|---|---|---|---|
| 283 | *Pavonia zeylanica* (L.) Cav. | Malvaceae | Herb | Terrestrial | Wild |
| 284 | *Pedalium murex* L. | Pedaliaceae | Herb | Terrestrial | Wild |
| 285 | *Peltophorum pterocarpum* (DC.) | Fabaceae | Tree | Terrestrial | Planted |
| 286 | *Pentatropis microphylla* L. | Asclepiadaceae | Climber | Terrestrial | Wild |
| 287 | *Pergularia daemia* (Forrsk.) Chiov. | Asclepiadaceae | Climber | Terrestrial | Wild |
| 288 | *Peristrophe bicalyculata* (Forssk.) Brummitt. | Acanthaceae | Herb | Terrestrial | Wild |
| 289 | *Persea macrantha* (Nees) Kosterm | Lauraceae | Tree | Terrestrial | Wild |
| 290 | *Phoenix sylvestris* (L.) Roxb. | Arecaceae | Tree | Terrestrial | Planted |
| 291 | *Phyllanthus emblica* L. | Euphorbiaceae | Tree | Terrestrial | Planted |
| 292 | *Phyllanthus maderaspatensis* L. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 293 | *Phyllanthus reticulatus* Poir. | Euphorbiaceae | Shrub | Terrestrial | Wild |
| 294 | *Phyllanthus urinaria* L. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 295 | *Physalis minima* Linn. | Solanaceae | Herb | Terrestrial | Wild |
| 296 | *Pithecellobium dulce* (Roxb.) Benth. | Fabaceae | Tree | Terrestrial | Planted |
| 297 | *Plumeria alba* L. | Apocynaceae | Tree | Terrestrial | Ornamental |
| 298 | *Plumeria rubra* L. | Apocynaceae | Tree | Terrestrial | Ornamental |
| 299 | *Polyalthia longifolia* (Sonner.) Thw. | Annonaceae | Tree | Terrestrial | Ornamental |
| 300 | *Polycarpaea corymbosa* (L.) Lam. | Caryophyllaceae | Herb | Terrestrial | Wild |
| 301 | *Polygala elongata* Klein ex Willd. | Polygalaceae | Herb | Terrestrial | Wild |
| 302 | *Pongamia pinnata* (L.) Pierre | Fabaceae | Tree | Terrestrial | Wild |
| 303 | *Portulaca oleracea* L. | Portulacaceae | Herb | Terrestrial | Wild |
| 304 | *Portulaca quadrifida* L. | Portulacaceae | Herb | Terrestrial | Wild |
| 305 | *Psidium guajava* L. | Myrtaceae | Tree | Terrestrial | Planted |
| 306 | *Pterolobium hexapetalum* (Roth.) Sant. & Wagh | Fabaceae | Straggler | Terrestrial | Wild |
| 307 | *Punica granatum* L. | Punicaceae | Tree | Terrestrial | Cultivated |
| 308 | *Pupalia lappacea* (L.) Juss. | Amaranthaceae | Herb | Terrestrial | Wild |
| 309 | *Quisqualis indica* L. | Combretaceae | Climber | Terrestrial | Cultivated |
| 310 | *Rauvolfia serpentina* (L.) Benth. ex kurz | Apocynaceae | Herb | Terrestrial | Wild |
| 311 | Rhizophora mucronata Poir. | Rhizophoraceae | Tree | Aquatic | Wild |
| 312 | Rotala densiflora (Roth ex Roem. & Schultes) Koehne | Lythraceae | Herb | Terrestrial | Wild |
| 313 | *Ruellia tuberosa* L. | Acanthaceae | Herb | Terrestrial | Wild |
| 314 | *Saccharum spontaneum* L. | Poaceae | Grass | Semi-aquatic | Wild |
| 315 | *Salicornia brachiata* Miq. | Chenopodiaceae | Shrub | Semi-aquatic | Wild |
| 316 | *Sapindus emarginatus* Vahl. | Sapindaceae | Tree | Terrestrial | Wild |
| 317 | *Sapium insigne* (Royle) Benth. | Euphorbiaceae | Tree | Terrestrial | Wild |

| | | | | | |
|---|---|---|---|---|---|
| 318 | *Schleichera oleosa* (Lour.) Oken | Sapindaceae | Tree | Terrestrial | Wild |
| 319 | *Scoparia dulcis* L. | Scrophulariaceae | Herb | Semi-aquatic | Wild |
| 320 | *Sebastiania chamaelea* (L.) Muell.-Arg. | Euphorbiaceae | Herb | Terrestrial | Wild |
| 321 | *Senna alata (L.) Roxb.* | Fabaceae | Shrub | Terrestrial | Ornamental |
| 322 | *Senna auriculata (L.) Roxb.* | Fabaceae | Shrub | Terrestrial | Wild |
| 323 | *Senna occidentalis* (L.) Link | Fabaceae | Herb | Terrestrial | Wild |
| 324 | *Senna tora* (L.) Roxb. | Fabaceae | Herb | Terrestrial | Wild |
| 325 | *Sesamum indicum* L. | Pedaliaceae | Shrub | Terrestrial | Cultivated |
| 326 | *Sesbania sesban* (Jacq.) W.Wight | Fabaceae | Tree | Terrestrial | Planted |
| 327 | Sesuvium portulacastrum (L.) L. | Aizoaceae | Herb | Aquatic | Wild |
| 328 | *Setaria italica (L.) P. Beauv* | Poaceae | Grass | Terrestrial | Wild |
| 329 | *Sida acuta* Burm.f. | Malvaceae | Herb | Terrestrial | Wild |
| 330 | *Sida cordata* (Burm. f.) Borss. | Malvaceae | Herb | Terrestrial | Wild |
| 331 | *Sida cordifolia* L. | Malvaceae | Herb | Terrestrial | Wild |
| 332 | *Sida rhombifolia* L. var. rhombifolia | Malvaceae | Herb | Terrestrial | Wild |
| 333 | *Smilax zeylanica* L. | Smilacaceae | Climber | Terrestrial | Wild |
| 334 | *Solanum surattense* Burm. f. | Solanaceae | Herb | Terrestrial | Wild |
| 335 | *Sonchus oleraceus* L. | Asteraceae | Herb | Terrestrial | Wild |
| 336 | Sonneratia caseolaris (L.) Engl. | Sonneratiaceae | Tree | Aquatic | Wild |
| 337 | *Spermacoce hispida* L. | Rubiaceae | Herb | Terrestrial | Wild |
| 338 | *Spermacoce ocymoides* Burm.f. | Rubiaceae | Herb | Terrestrial | Wild |
| 339 | *Spinifex littoreus* (Burm.f.) Merr. | Poaceae | Climber | Terrestrial | Wild |
| 340 | *Stephania japonica* (Thunb) Miers | Meninspermaceae | Climber | Terrestrial | Wild |
| 341 | *Sterculia villosa* Roxb.ex DC. | Sterculiaceae | Tree | Terrestrial | Cultivated |
| 342 | *Streblus asper* Lour. | Moraceae | Tree | Terrestrial | Wild |
| 343 | *Striga asiatica* (L.) Kuntze | Scrophulariaceae | Herb | Terrestrial | Wild |
| 344 | *Strychnos nux-vomica* L. | Strychnaceae | Tree | Terrestrial | Wild |
| 345 | *Suaeda nudiflora* (Willd) Moq. | Chenopodiaceae | Herb | Semi-aquatic | Wild |
| 346 | *Synedrella nodiflora* (L.) Gaertn. | Asteraceae | Herb | Terrestrial | Wild |
| 347 | *Syzigium caryophyllatum* L. | Myrtaceae | Tree | Terrestrial | Wild |
| 348 | *Syzygium caryophyllatum* (L.) Alston | Myrtaceae | Tree | Terrestrial | Wild |
| 349 | *Syzygium cumini* (L.) Skeels | Myrtaceae | Tree | Terrestrial | Planted |
| 350 | *Tamarindus indica* L. | Fabaceae | Tree | Terrestrial | Planted |
| 351 | *Tectona grandis* L.f. | Verbenaceae | Tree | Terrestrial | Wild |
| 352 | *Tephrosia purpurea* (L.) Pers. | Fabaceae | Herb | Terrestrial | Wild |
| 353 | *Tephrosia villosa* (L.) Pers. | Fabaceae | Herb | Terrestrial | Wild |
| 354 | *Terminalia alata* Heyne ex Roth | Combretaceae | Tree | Terrestrial | Wild |

| | | | | | |
|---|---|---|---|---|---|
| 355 | *Terminalia arjuna* (Roxb.ex DC.) Wight & Arn. | Combretaceae | Tree | Terrestrial | Wild |
| 356 | *Terminalia catappa* L. | Myrtaceae | Tree | Terrestrial | Cultivated |
| 357 | *Terminalia paniculata* Roxb. | Combretaceae | Tree | Terrestrial | Wild |
| 358 | Thespesia lampas (Cav.) Dalz. & Gibs | Malvaceae | Shrub | Terrestrial | Wild |
| 359 | Thespesia populnea (L.) Sol.ex Corr. | Malvaceae | Tree | Terrestrial | Wild |
| 360 | *Thespesia populnea* (L.) Soland ex Correa | Malvaceae | Tree | Terrestrial | Wild |
| 361 | *Thevetia peruviana* K.Schum | Apocynaceae | Tree | Terrestrial | Wild |
| 362 | *Thunbergia grandiflora* Roxb. | Acanthaceae | Straggler | Terrestrial | Ornamental |
| 363 | *Tinospora cordifolia* (Willd.) Miers ex Hook. f. & Thoms. | Menispermaceae | Climber | Terrestrial | Wild |
| 364 | *Trewia nudiflora* L. | Euphorbiaceae | Tree | Terrestrial | Wild |
| 365 | Trianthema portulacastrum L. | Aizoaceae | Herb | Aquatic | Wild |
| 366 | *Tribulus terrestris* L. | Zygophyllaceae | Herb | Terrestrial | Wild |
| 367 | *Trichodesma indicum* (L.) R. Br. | Boraginaceae | Herb | Terrestrial | Wild |
| 368 | *Tridax procumbens* L. | Asteraceae | Herb | Terrestrial | Wild |
| 369 | *Trigonella foenum-graecum* L. | Fabaceae | Herb | Terrestrial | Cultivated |
| 370 | *Triumfetta rhomboidea* Jacq. | Tiliaceae | Herb | Terrestrial | Wild |
| 371 | *Typha angustifolia* L. | Poaceae | Grass | Aquatic | Wild |
| 372 | *Urena lobata* L. subsp. *lobata* | Malvaceae | Herb | Terrestrial | Wild |
| 373 | *Vernonia cinerea* (L.) Less. | Asteraceae | Herb | Terrestrial | Wild |
| 374 | *Vigna mungo* (L.) Wilczek | Fabaceae | Herb | Terrestrial | Cultivated |
| 375 | *Vigna radiata* (L.) Verdc. | Fabaceae | Herb | Terrestrial | Cultivated |
| 376 | *Vigna trilobata* (L.) Verdc. | Fabaceae | Herb | Terrestrial | Wild |
| 377 | *Vitex altissima* Linn.f. | Verbenaceae | Tree | Terrestrial | Wild |
| 378 | *Waltheria indica* L. | Sterculiaceae | Herb | Terrestrial | Wild |
| 379 | *Xanthium indicum* Koen. | Asteraceae | Herb | Terrestrial | Wild |
| 380 | *Xylia xylocarpa* (Roxb.) Taub. | Fabaceae | Tree | Terrestrial | Wild |
| 381 | *Zanthoxylum rhetsa* (Roxb.) DC | Rutaceae | Tree | Terrestrial | Wild |
| 382 | *Ziziphus mauritiana* Lam. | Rhamnaceae | Tree | Terrestrial | Wild |
| 383 | *Ziziphus oenoplia* (L.) Mill. | Rhamnaceae | Straggler | Terrestrial | Wild |
| 384 | *Ziziphus xylopyrus* (Retz.) Will. | Rhamnaceae | Tree | Terrestrial | Wild |
| 385 | *Zornia gibbosa* Span. | Fabaceae | Herb | Terrestrial | Wild |

Hemidesmus indicus

Mucuna prurita

Caryota urens

Helictres isora

Ficus racemosa

Strychnos nux-vomica

**Habitat wise representation**

Based on habit types, among the 385 plant species, herbaceous plants were dominant in the study area and was represented with 142 species, followed by trees (121 species), shrubs (42 species) grasses (26 species) and climbers/stragglers with 43 species. Habitat wise representation of plants from the study area is given in table 4.16.

**Table 4.16 Habit wise representations of plants from the study area**

| Habit | No of species |
|---|---|
| Herb | 142 |
| Tree | 121 |
| Climber | 43 |
| Shrub | 42 |
| Grass | 26 |
| Straggler | 11 |
| Grand Total | 385 |

**Endangered plants**

Floristic studies were conducted during November 2013 to January 2014 to know the presence of any endangered/threatened/endemic plant species in and around proposed plant area and surrounding 10 km radius. The study area did not record the presence of any critically threatened species.

**National Park/Sanctuary**

As per Ministry of Environment & Forests Notifications and local forest notifications, there are no wildlife/bird sanctuaries/national parks/ biospheres in 10-km radius from plant site.

**Avifauna**

A total of 86 species of birds were observed during the present survey in the 10 km radial distance from the proposed project sites. The habitat types of the area include agricultural land, scrub jungle, plantation, seasonal ponds, marshlands and fallow grasslands. The common terrestrial species of the area include Indian Robin (*Saxicoloides fulicata*), Green Bee-eater (*Merops orientalis*), Blue Rock Piegon (*Columba livia*) and Red vented Bulbul (*Pycnonotus cafer*). The list of avifauna is presented in the following Table 4.17. Indian Peafowl is the only schedule-I species found in the surrounding areas of the airport site. They mostly found in the agricultural lands and scrub forest areas. The family wise species distribution is given in table 4.18.

**Table 4.17 List of birds documented during the study period**

| Sl.No | Common Name | Scientific Name | Family | Migratory Status |
|---|---|---|---|---|
| 1 | Alexandrine Parakeet | *Psittacula eupatria* | Psittacidae | O |
| 2 | Ashy Drongo | *Dicrurus leucophaeus* | Dicruridae | R |
| 3 | Asian Koel | *Eudynamys scolopacea* | Cuculidae | R |
| 4 | Asian Openbill-Stork | *Anastomus oscitans* | Ciconiidae | R |
| 5 | Asian Palm Swift | *Cypsiurus balasiensis* | Apodidae | R |
| 6 | Asian Paradise-Flycatcher | *Terpsiphone paradisi* | Muscicapidae | R |
| 7 | Asian Pied Starling | *Gracupica contra* | Sturnidae | R |
| 8 | Bank Myna | *Acridotheres ginginianus* | Sturnidae | R |
| 9 | Baya Weaver | *Ploceus philippinus* | Ploceinae | R |

| | | | | |
|---|---|---|---|---|
| 10 | Black Drongo | *Dicrurus macrocercus* | Dicruridae | R |
| 11 | Black Kite | *Milvus migrans* | Accipitridae | R |
| 12 | Black-naped Oriole | *Oriolus chinensis* | Oriolidae | R |
| 13 | Black-shouldered Kite | *Elanus caeruleus* | Accipitridae | R |
| 14 | Black-winged Stilt | *Himantopus himantopus* | Recurvirostridae | M |
| 15 | Blue Rock Pigeon | *Columba livia* | Columbidae | R |
| 16 | Blue-tailed Bee-eater | *Merops philippinus* | Meropidae | R |
| 17 | Brahminy Kite | *Haliastur indus* | Accipitridae | R |
| 18 | Cattle Egret | *Bubulcus ibis* | Ardeidae | R |
| 19 | Common Flameback Woodpecker | Dinopium javanense | Picidae | R |
| 20 | Common Hoopoe | *Upupa epops* | Upupidae | R |
| 21 | Common Iora | *Aegithina tiphia* | Aegithinidae | R |
| 22 | Common Myna | *Acridotheres tristis* | Sturnidae | R |
| 23 | Common Red Shank | *Tringa totanus* | Scolopacidae | M |
| 24 | Common Sandpiper | *Charadrius dubius* | Scolopacidae | M |
| 25 | Common Swallow | *Hirundo rustica* | Hirundinidae | M |
| 26 | Common Tailorbird | *Orthotomus sutorius* | Cisticolidae | R |
| 27 | Coppersmith Barbet | *Megalaima haemacephal* | Megalaimidae | R |
| 28 | Crested Serpent Eagle | *Spilornis cheela* | Accipitridae | R |
| 29 | Eurasian Collared Dove | *Streptopelia decaocto* | Columbidae | O |
| 30 | Eurasian Coot | *Fulica atra* | Rallidae | O |
| 31 | Glossy Ibis | *Plegadis falcinellus* | Threskiornithida | R |
| 32 | Golden Fronted Leafbird | *Chloropsis aurifrons* | Chloropseidae | R |
| 33 | Great Cormorant | *Phalacrocorax carbo* | Phalacrocoracid | O |
| 34 | Greater Coucal | *Centropus sinensis* | Cuculidae | R |
| 35 | Greater Short-toed Lark | *Calandrella brachydactyla* | Alaudidae | O |
| 36 | Green Bee-eater | *Merops orientalis* | Meropidae | R |
| 37 | Grey Heron | *Ardea cinerea* | Ardeidae | M |
| 38 | House Crow | *Corvus splendens* | Corvidae | R |
| 39 | House Sparrow | *Passer domesticus* | Passeridae | R |
| 40 | House Swift | *Apus nipalensis* | Apodidae | R |
| 41 | Indian Cuckoo | *Cuculus micropterus* | Cuculidae | R |
| 42 | Indian Peafowl | *Pavo cristatus* | Phasianidae | R |
| 43 | Indian Pond-Heron | *Ardeola grayii* | Ardeidae | R |
| 44 | Indian Robin | *Saxicolcides fulicata* | Muscicapidae | R |
| 45 | Indian Roller | *Coracias benghalensis* | Coraciidae | R |
| 46 | Intermediate Egret | *Mesophoyx intermedia* | Ardeidae | R |
| 47 | Jungle Babbler | *Turdoides striata* | Leiothrichidae | R |
| 48 | Jungle Crow | *Corvus macrorhynchos* | Corvidae | R |
| 49 | Jungle Myna | *Acridotheres fuscus* | Sturnidae | R |
| 50 | Large Pied Wagtail | *Motacilla maderaspatens* | Motacillidae | R |
| 51 | Lesser Coucal | *Centropus bengalensis* | Cuculidae | R |

| | | | | |
|---|---|---|---|---|
| 52 | Lesser Golden-backed Woodpecker | *Dinopium benghalense* | Picidae | O |
| 53 | Little Cormorant | *Phalacrocorax niger* | Phalacrocoracid | R |
| 54 | Little Egret | *Egretta Garzetta* | Ardeidae | R |
| 55 | Little Ringed Plover | *Charadrius dubius* | Charadriidae | R |
| 56 | Oriental Magpie-Robin | *Copsychus saularis* | Muscicapidae | R |
| 57 | Oriental White Ibis | *Threskiornis melanocephalus* | Threskiornithida | R |
| 58 | Paddyfield Pipit | *Anthus rufulus* | Motacillidae | R |
| 59 | Pied Bush Chat | *Saxicola caprata* | Muscicapidae | R |
| 60 | Pied Crested Cuckoo | *Clamator jacobinus* | Cuculidae | M |
| 61 | Pied Kingfisher | *Ceryle rudis* | Cerylidae | R |
| 62 | Plain Prinia | *Prinia inornata* | Cisticolidae | R |
| 63 | Purple Heron | *Ardea purpurea* | Ardeidae | R |
| 64 | Purple Sunbird | *Nectarinia asiatica* | Nectariniidae | R |
| 65 | Purple-rumped Sunbird | *Nectarinia zeylonica* | Nectariniidae | R |
| 66 | Red Whiskered Bulbul | *Pycnonotus jacosus* | Pycnonotidae | R |
| 67 | Red-rumped Swallow | *Hirundo daurica* | Hirundinidae | R |
| 68 | Red-vented Bulbul | *Pycnonotus cafer* | Pycnonotidae | R |
| 69 | Red-wattled Lapwing | *Vanellus indicus* | Charadriidae | R |
| 70 | Rose-ringed Parakeet | *Psittacula krameri* | Psittacidae | R |
| 71 | Rufous Treepie | *Dendrocitta vagabunda* | Corvidae | R |
| 72 | Rufous Woodpecker | *Micropternus brachyurus* | Picidae | O |
| 73 | Small Blue Kingfisher | *Alcedo atthis* | Alcedinidae | R |
| 74 | Spotted Dove | *Streptopelia chinensis* | Columbidae | R |
| 75 | Spotted Owlet | *Athene brama* | Strigidae | O |
| 76 | Stork-billed Kingfisher | *Pelargopsis capensis* | Halcyonidae | O |
| 77 | Watercock | *Gallicrex cinerea* | Rallidae | R |
| 78 | Whiskered Tern | *Chlidonias hybrida* | Sternidae | R |
| 79 | White Wagtail | *Motacilla alba* | Motacillidae | R |
| 80 | White-breasted Kingfisher | *Halcyon smyrnensis* | Alcedinidae | R |
| 81 | White-breasted Water hen | *Amaurornis phoenicurus* | Rallidae | R |
| 82 | White-cheeked Barbet | *Megalaima viridis* | Megalaimidae | O |
| 83 | White-headed Babbler | *Turdoides leucocephala* | Timaliidae | R |
| 84 | White-rumped Munia | *Lonchura striata* | Estrildidae | O |
| 85 | Wood Sandpiper | *Tringa glareola* | Scolopacidae | R |
| 86 | Yellow Wagtail | *Motacilla flava* | Motacillidae | R |

Note: R-Resident; M-migratory, O-Occasional

**Table 4.18 Family wise distribution in and around the study area**

| Family | No of Species |
|---|---|
| Ardeidae | 6 |
| Cuculidae | 5 |
| Accipitridae | 4 |
| Motacillidae | 4 |
| Muscicapidae | 4 |
| Sturnidae | 4 |
| Columbidae | 3 |
| Corvidae | 3 |
| Picidae | 3 |
| Rallidae | 3 |
| Scolopacidae | 3 |
| Alcedinidae | 2 |
| Apodidae | 2 |
| Charadriidae | 2 |
| Cisticolidae | 2 |
| Dicruridae | 2 |
| Hirundinidae | 2 |
| Megalaimidae | 2 |
| Meropidae | 2 |
| Nectariniidae | 2 |
| Phalacrocoracidae | 2 |
| Psittacidae | 2 |
| Pycnonotidae | 2 |
| Threskiornithidae | 2 |
| Aegithinidae | 1 |
| Alaudidae | 1 |
| Cerylidae | 1 |
| Chloropseidae | 1 |
| Ciconiidae | 1 |
| Coraciidae | 1 |
| Estrildidae | 1 |
| Halcyonidae | 1 |
| Leiothrichidae | 1 |
| Oriolidae | 1 |
| Passeridae | 1 |
| Phasianidae | 1 |
| Ploceinae | 1 |
| Recurvirostridae | 1 |
| Sternidae | 1 |
| Strigidae | 1 |
| Timaliidae | 1 |
| Upupidae | 1 |
| **Grand Total** | **86** |

**Butterflies**

A total of 33 butterfly species belonging to 5 families were recorded during the present study (Table 4.19). At family level, the family Nymphalidae is the dominant one with 16 species followed by Pieridae with 6 species, Lycaenidae with 5 species and Papilionidae with 5 species. The family wise distribution of butterflies is given in Table 4.20. Species such as Common Jezebel, Plain Tiger, Common Indian Crow, and Common Grass Yellow were commonly seen in and around the proposed project site. Crimson Rose, Danaid Eggfly and Common Pierrot are protected under schedule-I of Indian Wildlife Protection Act 1972. Crimson Rose are endemic species found occurring in the present study area, the distributions of which are restricted to the Peninsular India and Srilanka (Kunte, 2000).

**Table 4.19 List of butterflies in and around the study area**

| S.No | Common Name | Scienticfic Name | Family |
|---|---|---|---|
| 1 | Angled Pierrot | *Caleta caleta* | Lycaenidae |
| 2 | Blue Pansy | *Junonia orithya* | Nymphalidae |
| 3 | Blue Tiger | *Tirumala limniace* | Nymphalidae |
| 4 | Chocolate Pansy | *Junonia iphita* | Nymphalidae |
| 5 | Common Emigrant | *Catopsilia pomona* | Pieridae |
| 6 | Common Grass Yeliow | *Eurema hecabe* | Pieridae |
| 7 | Common Gull | *Cepora nerissa* | Pieridae |
| 8 | Common Indian Crow | *Euploea core* | Nymphalidae |
| 9 | Common Jay | *Graphium doson* | Papilionidae |
| 10 | Common Jezebel | *Delias eucharis* | Pieridae |
| 11 | Common Leopard | *Phalanta phalanta* | Nymphalidae |
| 12 | Common Lime Butterfly | Papilio demoleus | Papilionidae |
| 13 | Common Mormon | *Papilio polytes* | Papilionidae |
| 14 | Common Pierrot | *Castalius rosimon* | Lycaenidae |
| 15 | Common Rose | *Pachliopta aristolochiae* | Papilionidae |
| 16 | Common Sailor | *Neptis hylas* | Nymphalidae |
| 17 | Common Wanderer | *Pareronia valeria* | Pieridae |
| 18 | Crimson Rose | *Pachliopta hector* | Papiiionidae |
| 19 | Danaid Eggfly | *Hypolimnas misippus* | Nymphalidae |
| 20 | Glassy Tiger | *Parantica algea* | Nymphalidae |
| 21 | Great Eggfly | *Hypolimnas bolina* | Nymphalidae |
| 22 | Grey Pansy | *Junonia atlites* | Nymphalidae |
| 23 | Lemon Pansy | *Junonia lemonias* | Nymphalidae |
| 24 | Lesser Grass Blue | *Zizina otis* | Lycaenidae |
| 25 | Mottled Emigrant | *Catopsilia pyranthe* | Pieridae |
| 26 | Peacock Pansy | *Junonia almana* | Nymphalidae |
| 27 | Plain Tiger | *Danaus chrysippus* | Nymphalidae |
| 28 | Plains Cupid | *Chilades pandava* | Lycaenidae |
| 29 | Plum Judy | *Abisara echerius* | Riodinidae |

| | | | |
|---|---|---|---|
| 30 | Striped Tiger | *Danaus genutia* | Nymphalidae |
| 31 | Tawny Coster | *Acraea terpsicore* | Nymphalidae |
| 32 | Yamfly | *Loxura atymnus* | Lycaenidae |
| 33 | Yellow Pansy | *Junonia hierta* | Nymphalidae |

**Table 4.20 Family wise distribution of butterflies in the study area**

| Family | No of species |
|---|---|
| Nymphalidae | 16 |
| Pieridae | 6 |
| Lycaenidae | 5 |
| Papilionidae | 5 |
| Riodinidae | 1 |
| Grand Total | 33 |

**Amphibians**

Based on field observations and the available secondary information, a total of 5 species of amphibians were recorded from the study area as given in the following Table 4.21.

**Table 4.21 List of amphibians recorded in the study area**

| Sl No | Common Name | Scientific Name | Family |
|---|---|---|---|
| 1 | Asian Common Toad | *Bufo melanostictus* | Bufonidae |
| 2 | Common Tree Frog | *Polypedates maculatus* | Rhacophoridae |
| 3 | Indian Skipper Frog | *Euphlyctis cyanophlyctis* | Ranidae |
| 4 | Indus Valley Toad | *Duttaphrynus stomaticus* | Bufonidae |
| 5 | Paddyfield Frog | *Fejervarya limnocharis* | Dicroglossidae |

**Reptiles**

Based on field observations and the available secondary information, a total of 12 species of reptiles were recorded from the study area as given in the following Table 4.22.

**Table 4.22 List of reptiles recorded in the study area**

| Sl No | Common Name | Scientific Name | Family |
|---|---|---|---|
| 1 | Asian House Gecko | *Hemidactylus frenatus* | Gekkonidae |
| 2 | Banded Racer | Argyrogena fasciolata | Colubridae |
| 3 | Brahminy worm snake | *Ramphotyphlops braminus* | Typhlopidae |
| 4 | Checkered Keelback | Xenochrophis piscator | Colubridae |
| 5 | Common House Gecko | *Hemidactylus flaviviridis* | Gekkonidae |
| 6 | Common Krait | Bungarus Coeruleus | Elapidae |
| 7 | Common Kukri Snake | Oligodon arnensis | Colubridae |
| 8 | Common Skink | *Mabuya macularia* | Scincidae |
| 9 | Common Trinket | *Coelognathus helena* | Colubridae |

| | | | |
|---|---|---|---|
| | Snake | *helena* | |
| 10 | File Snake | Acrochordus granulatus | Acrochordidae |
| 11 | freshwater crocodile | *Crocodylus johnsoni* | Crocodylidae |
| 12 | Green Vine Snake | *Ahaetulla nasuta* | Colubridae |
| 13 | Indian Chameleon | *Chamaleon zeylanicus* | Chamaelecnidae |
| 14 | Indian Cobra | Naja naja | Elapidae |
| 15 | Indian fan-throated lizard | *Sitana ponticeriana* | Agamidae |
| 16 | Indian Rat Snake | *Ptyas mucosa* | Colubridae |
| 17 | Little Skink | *Lygosoma punctata* | Scincidae |
| 18 | Oriental Garden Lizard | *Calotes versicolor* | Agamidae |

**Mammals**

There are no major wild animals in the study area of 10 km radius and 11 mammals were recorded in study area (Table 4.23). There is no visual sighting of any threatened species as mentioned in the Indian Wildlife Protection Act, 1972.

**Table 4.23 Mammals recorded in the study area**

| Sl No | Common Name | Scientific Name | Familiy | IUCN Category |
|---|---|---|---|---|
| 1 | Bengal Fox | *Vulpes bengalensis* | Canidae | LC |
| 2 | Black-napped Hare | *Lepus nigricollis* | Leporidae | LC |
| 3 | Common House Mouse | *Mus musculus* | Muridae | LC |
| 4 | Common House Rat | *Rattus rattus* | Muridae | LC |
| 5 | Common Mongoose | *Herpestes edwardsi* | Herpestidae | DD |
| 6 | Domestic Cat | *Felis catus* | Felidae | LC |
| 7 | Domestic Cattle | *Bos taurus* | Bovidae | LC |
| 8 | Domestic Dog | *Canis familiaris* | Canidae | LC |
| 9 | Jackal | *Canis aureus* | Canidae | LC |
| 10 | Three-striped Palm squirrel | *Funambulus palmarum* | Sciuridae | LC |

**Ecologically Sensitive Zones**

Ministry of Environment and Forests had constituted a High Level Working Group (HLWG) under the Chairmanship of Dr. K. Kasturirangan, Member (Science), Planning Commission vide office order dated 17.08.2012 to study the preservation of the ecology, environmental integrity and holistic development of the Western Ghats in view of their rich and unique biodiversity. HLWG submitted its report to the MoEF on 15th April 2013. HLWG identified 37% of natural landscape having high biological richness, low forest fragmentation, low population density and containing Protected Areas, World Heritage Sites and Tiger and Elephant corridors as an Ecologically Sensitive Areas (ESA).

The present proposed airport site is falling under Pernem taluka of North Goa district. The Pernem taluka has not been included in the Ecologically Sensitive Areas submitted by HLWG. The MoEF order on ESA is attached as Annexure II.

# CHAPTER 5

# IMPACT ANALYSIS AND MITIGATION MEASURES

## 5.0 IMPACT PREDICTION

In chapter four, various environmental elements, which are susceptible to impacts and the project activities that are likely to cause these impacts, have been identified. In this chapter the likely impacts have been evaluated by assessing their magnitude. Assessment is then carried out by weighting the magnitude of such impacts vis-a-vis the importance in terms of the environment.

The impact of the proposed facilities on the environment has been studied by comparing the load on environment before and after implementation of the proposed green field. The impact of the project has been studied for various phases for implementation i.e., during construction and operation.

## 5.1 METHODOLOGY

The methodology adopted for assessing the potential positive and negative environmental impacts from the proposed project is described below.

Step1: Identification of environmental impacts

All potential releases (emissions to air, generation of noise, effluent discharge, spills & leaks, etc.) from the construction & operation phases of the proposed project are identified. The potential positive and negative environmental impacts from these releases and other activities of the project have been identified.

Step2: Environmental impact assessment

The Significance (S) of the Environmental Impacts is identified and assessed by the following characteristics:

- Intensity (I) of the environmental impact;
- Spatial extension (Sp) of the environmental impact;
- Temporal duration (T) of the environmental impact;&
- Environmental Vulnerability (V) of the impacted area.

Determination of Impact Intensity (I)

Impact Intensity has been assessed based on the following criteria:

**H (High):**

- Emissions/generation of highly pollutant substances, emissions/generation of high quantity of pollutant substances and/or high noise emission
- High consumption of resources (such as energy, water, land, fuel, chemicals)
- Felling of large of trees or death of fauna

**M (Medium):**

- Emissions/generation of moderately pollutant substances, emissions/generation of moderate quantity of poilutant substances and/or moderately high noise emission
- Moderate consumptic n of resources (such as energy, water, land, fuel, chemicals)
- Felling of few trees or physical damage of fauna

**L (Low):**

- Emissions/generation of low pollutant substances, emissions/generation of low quantity of pollutant substances and/or low noise emission
- Low consumption of resources (such as energy, water, land, fuel, chemicals)
- Damage to few trees or disturbance/ disorientation of fauna

**N (Negligible):**

- Emissions/generation of very low pollutant substances, emissions/generation of very low quantity of pollutant substances and/or very low noise emission
- Very low consumption of resources (such as energy, water, land, fuel, chemicals)
- No measurable damage to flora/fauna

Determination of Impact Spatial extension (Sp) and Spatial Criteria (Is)

Impact Spatial extension has been assessed based on the following criteria:

- **H (High):** the impact extends in a wide area cutside the site (about 10 km or more)
- **M (Medium):** the impact extends in a restricted area outside the site (< 10 km)
- **L (Low):** the impact extends inside the site.
- **N (Negligible):** the impact extends in a restricted area inside the site.

The product of Impact Intensity and Impact Spatial extension gives the impact evaluation as per Spatial criteria (Is).

**Table 5.1: Matrix for Evaluating Spatial criteria**

| Impact evaluation as per SPATIAL CRITERIA (Is) | | Impact Spatial extension (Sp) | | | |
|---|---|---|---|---|---|
| | | HIGH | MEDIUM | LOW | NEGLIGIBLE |
| Impact Intensity (I) | HIGH | | | | |
| | MEDIUM | | M | M | M |
| | LOW | M | | | |
| | NEGLIGIBLE | N | N | N | N |

**Determination of Impact Temporal duration (T) and Temporal Criteria (It)**

Impact Temporal Duration has been assessed based on the following criteria:

- **H (Very High):** the impact has an important long-term effect (> 5 years)
- **H (High):** the impact has an important long-term effect (1-5 years)
- **M (Medium):** the impact has a medium-term effect (1 week – 1 year)
- **L (Low):** the impact has a temporary and short-term effect (1 day – 1 week)
- **N (Negligible):** the impact has an immediate effect and it is solved in a very short time.

The product of Impact Temporal duration and Spatial criteria gives the impact evaluations as per Temporal Criteria (It).

**Table 5.2: Matrix for Evaluating Temporal criteria**

| Impact evaluation as per TEMPORAL CRITERIA (It) | | Impact Temporal duration (T) | | | | |
|---|---|---|---|---|---|---|
| | | VERY HIGH | HIGH | MEDIUM | LOW | NEGLIGIBLE |
| Impact Is | HIGH | | | | | |
| | MEDIUM | | M | M | M | |
| | LOW | M | M | | | |
| | NEGLIGIBLE | N | N | N | N | N |

**Determination of Environmental Vulnerability (V) and Significance (S)**

Environmental Vulnerability has been assessed based on the following criteria:

- **H** (High): Particular interesting area from the environmental, historical, social point of view. Parks, natural reserves and / or special areas of conservation. Contaminated areas in which a further impact may generate non-compliance with local environmental limits.
- **M** (Medium): Interesting area from the environmental, historical, social point of views. Residential areas with low population density. Agricultural areas, forests, public parks.
- **L** (Low): Industrial and commercial areas.

The product of Vulnerability and Temporal criteria gives the Significance of the impact.

**Table 5.3: Matrix for Evaluating Significance**

| Impact evaluation as per VULNERABILITY CRITERIA (SIGNIFICANCE S) | | VULNERABILITY (V) | | |
|---|---|---|---|---|
| | | HIGH | MEDIUM | LOW |
| Impact It | HIGH | | | M |
| | MEDIUM | | M | M |
| | LOW | M | M | |
| | NEGLIGIBLE | | N | N |

The Impact Significance (S) levels obtained from the above-matrix are defined as follow:

- **H** (High): Causes severe and acute effects to receptors, severe and irreversible deterioration of the quality of environment, and irreversible modification of landscape or of ecological equilibrium.

- **M** (Medium): Causes moderate effects to receptors, reversible deterioration of the quality of environment, and reversible modifications of landscape or ecological equilibrium.

- **L** (Low): Causes limited effects to receptors, quickly reversible deterioration of the quality of environment, and slight and reversible modification of landscape or ecological equilibrium.
- **N** (Negligible): Causes negligible or no effects to receptors, slight and reversible deterioration of quality of the environment, no measurable changes at landscape or ecological level.

The assessment has been carried out for each of the potential environmental impacts during both construction and operation, and has been discussed in this chapter.

## 5.2 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

The environmental impacts associated with the proposed project on various environmental components such as air, water, noise, soil, flora, fauna, land, socioeconomic, etc. has been identified using Impact Identification Matrix (**Table 5.4**).

## Table 5.4: Impact Identification Matrix

| Activities | Ambient air quality | Ground / surface water (quantity / quality) | Ambient noise | Land (land use, topography & drainage, soil) | Flora | Fauna | Livelihood & occupation | Infrastructure |
|---|---|---|---|---|---|---|---|---|
| **CONSTRUCTION** | | | | | | | | |
| Civil and mechanical works | × | × | × | × | × | × | × | × |
| Movement of vehicles | × | | × | | | × | | × |
| Waste water generation, handling and disposal | | × | | × | | | | × |
| Solid waste generation, handling and disposal | | | | × | | | | × |
| **OPERATION** | | | | | | | | |
| movement of Aircrafts during landing and takeoff | × | | × | | | | | |
| Storage of Fuel | × | | | | | | | |
| Cleaning & maintenance | | × | | × | | | | |
| Operation of emergency power generation facility | × | | × | | | | | |
| Waste water generation, handling and disposal | | × | | × | | | | |
| Solid waste generation, handling and disposal | | | | × | | | | |
| Movement of vehicles | × | | × | | | × | | × |

## 5.3 IMPACT EVALUATION AND MITIGATION MEASURES

### 5.3.1 AIR ENVIRONMENT

**Construction Phase**

**Impact Evaluation**

Potential emissions sources during construction phase include the following:

- Operation of construction equipment and machinery for earth-moving, grading and civil works at proposed Airport location.
- Storage and handling of construction material (e,g. sand, cement) at aiport site
- Operation of temporary Diesel Generator (DG) sets
- Movement of vehicles carrying equipment, construction material and project-related personnel

The impacts are described below:

- Dust will be generated from earth-moving, grading and civil works, and movement of vehicles on unpaved roads.

PM, CO, NOx, & SOx will be generated from operation of diesel sets and diesel engines of machineries and vehicles.

The significance of the impacts of air emissions on ambient air quality during construction phase is summarized in **Table 5.5**.

**Table 5.5: Impact of air emissions (construction phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Emissions of low quantity/Low consumption of power |
| Spatial | Low | Impact extends inside the site |
| Temporal | Low | The impact has a temporary and short term effect (1 day – 1 week) |
| Vulnerability | Low | Open area |
| **Evaluation of factors** | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors as per methodology given in Section 5.1 |
| Impact($I_t$) | Low | By combining Is and temporal factors as per methodology given in Section 5.1 |
| **Overall Significance Value of Impact (S)** | **Low** | By combining It and Vulnerability factors as per methodology given in Section 5.1 |

**Mitigation Measures**

- Ensuring preventive maintenance of vehicles and equipment.
- Ensuring vehicles with valid Pollution under Control certificates are used.
- Avoiding unnecessary engine operations.
- Implementing dust control activities such as water sprinkling on unpaved sites.

- Ensure vertical stacks with height sufficient for dispersion as per CPCB guidelines.

**Operation Phase**

**Impact Evaluation**

The potential emissions source during operation phase include the following:

- Movement of Aircrafts during takeoff and landing
- Operation of emergency power generator sets
- Storage of fuel
- Movement of vehicles.

**Impact due to Air movement**

Aviation Turbine Fuel (ATF) in a turbofan or turboprop engine releases gases into the atmosphere. The most important emission types to be considered are: carbon dioxide or $CO_2$, water (vapour) or $H_2O$, nitrogen oxides or $NO_x$, carbon monoxide or CO, hydrocarbons or $C_xH_y$, sulfur dioxide or $SO_2$, and soot. $CO_2$ and $H_2O$ are the products of complete burning of which fixed amounts are formed with the burning of each kg of fuel. $NO_x$ is formed under high pressure and temperature in the combustion chamber the amounts of $NO_x$ produced depend on engine working conditions and thrust setting. Substances resulting from incomplete burning, such as CO, $C_xH_y$ and soot are mainly produced when the engines are not operating at optimal conditions, which particularly occurs during landing, taxiing, take-off and climb-out. $SO_2$ is produced as a consequence of the small sulphur content in ATF. The most important pollution problems experienced at ground level to which aircraft engine emissions contribute are smog formation (due to emissions of $NO_x$ and $C_xH_y$ )(AERO Model, 1994, Dutch Civil Aviation Authority).

The emissions of HC, CO and $NO_x$ from different types of aircrafts i.e small , medium and large are estimated using emission indices given in Emission Database of International Civil Aviation Organisation (ICAO) and are given below:

**Table 5.6: Emissions of air pollutants**

| Engine Model | Take off | Climbing off | Approaching | Idle | Highest EI g/kg of fuel used (1) | Condition | Fuel flow at that Condition (Kg/s) (2) | Time in minutes | Emission for one flight in g/s ((1) x (2)) |
|---|---|---|---|---|---|---|---|---|---|
| | **Emission Index for HC in g/Kg** | | | | | | | | |
| **A 320** | | | | | | | | | |
| CFM 56 - 5 A1 | 0.23 | 0.23 | 0.40 | 1.4 | | | | | |
| **Boeing 737** | | | | | | | | | |
| CFM56-7B27 | 0.10 | 0.10 | 0.10 | 1.70 | | | | | |
| CFM56-7B27/2 | 0.05 | 0.06 | 4.21 | 5.56 | **5.56** | **Idling** | **0.115** | **19** | **0.64** |
| **Boeing 777-200LR** | | | | | | | | | |
| GE 90-115B | 0.04 | 0.03 | 0.06 | 4.24 | | | | | |
| | **Emission Index for CO in g/Kg** | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **A 320** | | | | | | | | | |
| CFM 56 – 5 A1 | 0.9 | 0.9 | 2.5 | 17.6 | | | | | |
| **Boeing 737** | | | | | | | | | |
| CFM56-7B27 | 0.20 | 0.50 | 1.40 | 17.90 | | | | | |
| CFM56-7B27/2 | 0.54 | 1.97 | 24.28 | 38.73 | | | | | |
| **Boeing 777-200LR** | | | | | | | | | |
| GE 90-115B | 0.08 | 0.07 | 1.98 | 39.11 | **39.11** | **Idling** | **0.389** | **26** | **14.36** |
| | | | | | | | | | |
| | **Emission Index for $NO_x$ in g/Kg** | | | | | | | | |
| **A 320** | | | | | | | | | |
| CFM 56 – 5 A1 | 24.6 | 19.6 | 8.0 | 4.0 | | | | | |
| **Boeing 737** | | | | | | | | | |
| CFM56-7B27 | 30.90 | 23.70 | 11.00 | 4.80 | | | | | |
| CFM56-7B27/2 | 20.81 | 15.59 | 7.53 | 4.36 | | | | | |
| **Boeing 777-200LR** | | | | | | | | | |
| GE 90-115B | 50.34 | 35.98 | 16.5 | 5.19 | **50.34** | **Take off** | **4.690** | **0.7** | **236** |
| | | | | | | | | | |

From the above table, it can be noted that the maximum emission of HC and CO shall be 0.64 g/s and 14.86 g/s for a period of 19 minutes and 26 minutes respectively & 236 g/s of $NO_x$ for a period of 42 seconds only, which are insignificant. It is to be noted that the release occurs in such short time intervals and in an open corridor present on both sides of runway emissions shall get dispersed and impact remains within the boundaries.

Hence, there shall be marginal addition of pollutants in the operational phase owing to clean fuel and time gap between the operations, the proposed project has no impact on air environment at ground level. Moreover, the impact shall be limited to within the boundaries of airport.

**Impact due to increase in Passenger Traffic**

Traffic increase shall also have an impact on air quality. Ambient air qualities monitored in terms of SPM, RPM, SO2, NOX, HC and CO at six locations were found well within permissible limits, and are summarised below.

| Parameter | Monitored Value ($\mu g/m^3$) | NAAQS ($\mu g/m^3$) |
|---|---|---|
| SPM | 29- 53 | 200 |
| RPM | 14- 28 | 100 |
| SO2 | 7.6- 18.5 | 80 |
| $NO_x$ | 9- 21.8 | 80 |

Both CO and HC were found <100 $\mu g/m^3$

**Emission from Emergency power generation set**

Emergency power generation sets at the airport facilities are expected to run for a maximum of 3 – 4 hours in a day leading to minimal impact on air environment.

All fuel tanks are of light hydrocarbons which has negligible fugitive HC emissions.

The significance of the impacts of air emissions on ambient air quality during operation phase is summarized in **Table 5.7.**

**Table 5.7: Impact of air emissions (operation phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Emissions of low quantity. Existing baseline concentrations for all the pollutants are found well within prescribed National Ambient Air Quality Standards (NAAQS) |
| Spatial | Low | Dispersion of these emissions leading to Groung level concentration (GLC) lies inside the site. |
| Temporal | High | the impact has an important long-term effect (1-5 years) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors as per methodology given in Section 5.1 |
| Impact($I_t$) | Medium | By combining $i_s$ and temporal factors as per methodology given in Section 5.1 |
| **Overall Significance Value of Impact(S)** | **Medium** | By combining $I_t$ and Vulnerability factors as per methodology given in Section 5.1 |

**Mitigation measures**

- Developing peripheral green belt in the proposed new premises.
- Ensuring preventive maintenance of vehicles and equipment.
- Avoiding unnecessary engine operations (e.g. equipment with intermitted use switched off when not working)
- Ensuring vehicles with valid Pollution Under Control certificates are used.

## 5.3.2 WATER ENVIRONMENT

**Construction Phase**

**Impact Evaluation**

The impact on water environment during the construction phase of the proposed changes shall be in terms of water demand and waste water generation due to construction activities. Approximately, 2 MLD of water will be required for construction and domestic purposes..

The significance of the impact of raw water consumption on local water resources during construction phase is summarized in **Table 5.8.**

**Table 5.8: Impact of water consumption (construction phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Medium | Moderate consumption of raw water |
| Spatial | Medium | the impact extends in a restricted area outside the site (< 10 km) |
| Temporal | Low | The impact has a temporary and short term effect (1 day – 1 week) |
| Vulnerability | Low | Designated Industrial area |
| Evaluation of factors | | |
| Impact($I_s$) | Medium | By combining intensity and spatial factors |
| Impact($I_t$) | Medium | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact(S)** | **Medium** | By combining $I_t$ and Vulnerability factors |

The effluent streams that will be generated regularly during construction stage include the following:

- Sewage and grey water from construction camps and work sites
- Cleaning and washing water for vehicle and equipment maintenance area.

- During construction phase, used construction water is the only effluent generated due to construction activities and most of the effluent generated will be so small that it will either get percolated to ground or get evaporated. And 0.5 MLD of sanitary waste generated will be treated in STP package

The significance of the impact of raw water consumption on local water resources during construction phase is summarized in **Table 5.9.**

**Table 5.9: Impact of effluent generation (construction phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Releases of low quantity |
| Spatial | Low | Impact extends in a restricted area outside the site (< 1 km) |
| Temporal | Low | The impact has a temporary and short term effect (1 day – 1 week) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact(S)** | **Low** | By combining $I_t$ and Vulnerability factors |

**Mitigation Measures**

- Monitoring water usage at construction camps to prevent wastage.
- Ensuring there are no chemical or fuel spills at water body crossings.
- Ensuring that the STP at construction camps/ sites and the proposed facilities are properly designed to handle peak waste water load and properly maintained.
- Ensuring supply of temporary/ portable toilets for construction staff.

**Operation Phase**

**Impact Evaluation**

The impact on water environment during the operation phase of the proposed changes shall be in terms of water consumption and waste water generation. As the project will be implemented in four phases, the estimated water requirements for the year 2020, 2030, 2045 and beyond 2045 are 1MLD, 1.8 MLD, 3 MLD and 6 MLD respectively. Water is used for domestic purposes mainly.

The impact of water consumption on local resources during operation phase is summarized in **Table 5.10**.

**Table 5.10: Impact of water consumption (operation phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Low consumption of raw water at each site |
| Spatial | Medium | the impact extends in a restricted area outside the site (< 10 km) |
| Temporal | High | the impact has an important long-term effect (1-5 years) |
| Vulnerability | Low | Designated Industrial area |
| Evaluation of factors | | |
| Impact($I_s$) | Medium | By combining intensity and spatial factors |
| Impact($I_t$) | Medium | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Medium** | By combining $I_t$ and Vulnerability factors |

The estimated sewage generation is assumed as 80% of the water supply. The estimated sewage generation is therefore about 1.5 MLD and 2.4 MLD for the year 2030 and 2045, respectively. The maximum water demand and sewage generation beyond year 2045 is estimated as 6 MLD and about 5 MLD, respectively.

The sewage from terminal building, catering, housing, hotels, commercial areas and other business areas would be collected through a gravity sewerage system leading to a sewage pumping station. The treated effluent quality will be suitable for use in landscape/garden area, flushing of urinals and toilets etc.

The impact of effluent generation during operation phase is summarized in **Table 5.11**.

**Table 5.11: Impact of effluent generation (operation phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Releases of low quantity |
| Spatial | Low | Impact extends in a restricted area outside the site (< 1 km) |
| Temporal | Low | The impact has a temporary and short term effect (1 day – 1 week) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Low** | By combining $i_t$ and Vulnerability factors |

**Mitigation Measures**

- Tracking of consumption and installing water meter at any new water abstraction source.
- Installation of rainwater harvesting structures to collect and use rainwater, thereby reducing abstraction. A general arrangement of rain water pits is shown Annexure III. Location of the rainwater harvesting pits has been maked in annexure II.
- Exploring opportunities for recharging of rainwater to augment local ground water resources.
- Exploring opportunities for drip irrigation system for greenbelt development to reduce water demand.

### 5.3.3 LAND ENVIRONMENT

**Drainage Pattern of Study Area**

Topography and Geology

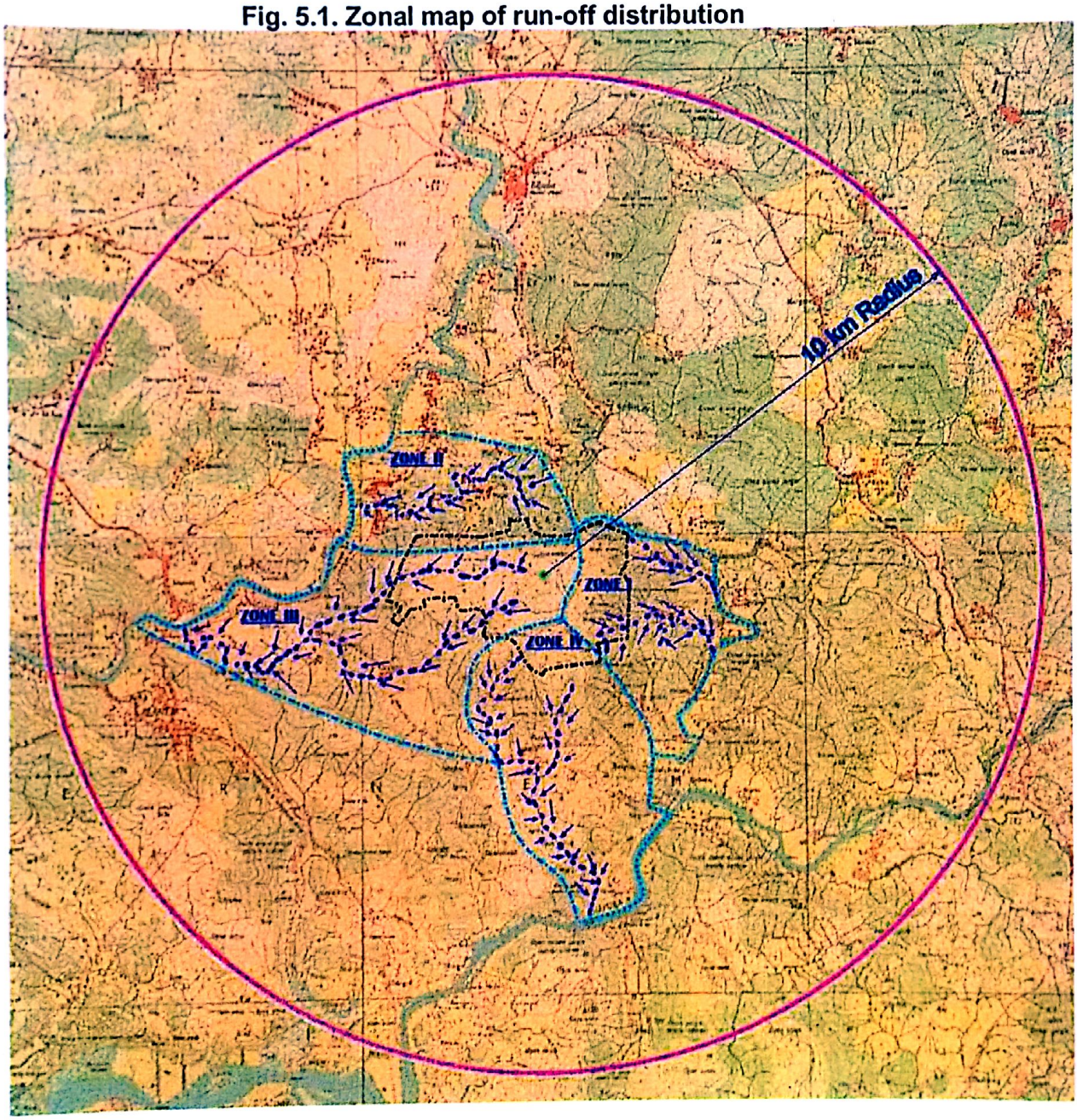
The topography at the airport site consists of mildly undulating plateau type of ground sloping gently upward from west to east of levels from 140m to 170m above mean sea level (MSL). There are three natural drains over the plateau flowing westward. The natural surface consists of a layer of laterite of various thickness and strengths. Shallow layers of reddish brown sandy soil are found at several depressed locations. Compact coarse to medium grained sand containing soil layer generally underlies the laterite

Climate

Goa features a tropical monsoon climate under the Koppen climate classification. Goa, being in the tropical zone and near the Arabian Sea, has a hot and humid climate for most of the year. The month of May is the hottest, seeing day temperatures of over 35 °C (95 °F) coupled with high humidity. The monsoon rains arrive by early June and provide a much needed respite from the heat. Most of Goa's annual rainfall is received through the

monsoons which last till late September. The site can be divided into 4 catchments according to the number of outfalls at the boundary which drains to the West and South of the site. The remaining area drains to the North and East. With the development of Airport infrastructure, the area contributing to the North or East will reduce and the reduced area will then contribute to the West and South side outfalls. Therefore there will not be any adverse impact on the drainage on the North and East side of site

**Fig. 5.1. Zonal map of run-off distribution**




Peak Hour Discharge from Existing Outfalls

The discharge calculation is done using the Rational Formula Q = C.I.A

where,

C= Coefficient of runoff (considered as 0.7, for lightly covered plateaus)

I = Intensity corresponding to time of Concentration

A = Catchment Area

Time of Concentration has been calculated using the formula $Tc = (0.87 . L^3 / H)^{0.385}$

**Table 5.12 a: Estimation of run-off in buffer zone of 10 km radius**

| | Before construction of Airport | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| zone | area(km2) | in hectares | c=coeffecient | length in km. | height diff | tc | intensity | flow (m3) |
| 1 | 10.144 | 1014.4 | 0.7 | 2.4375 | 150 | 0.384384 | 250 | 655824 |
| 2 | 9.7 | 970 | 0.7 | 2.84 | 120 | 0.500073 | 250 | 628075 |
| 3 | 19 | 1900 | 0.7 | 8.12 | 100 | 1.811008 | 250 | 1230250 |
| 4 | 14.28 | 1428 | 0.7 | 4.88 | 120 | 0.93601 | 250 | 924630 |

**Table 5.12 b: Estimation of run-off within the project boundary**

| | After construction of Airport | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| zone | area(km2) | in hectares | c=coeffecient | length in km. | Elevation diff | tc | Intensity | flow (m3) |
| 1 | 2.8 | 280 | 0.7 | 2.4375 | 150 | 0.384384 | 250 | 181300 |
| 2 | 1.15 | 115 | 0.7 | 2.84 | 120 | 0.500073 | 250 | 74452.5 |
| 3 | 5.07 | 507 | 0.7 | 8.12 | 100 | 1.811008 | 250 | 328282.5 |
| 4 | 0.89 | 89 | 0.7 | 4.88 | 120 | 0.93601 | 250 | 57627.5 |

Run-off zone-I:
L=2.4375 km
H=150m
Using graph and tc formula I=275
Q=181300m3 hourly peak

Run-off zone-II:
L=2.84 km
H=120m
Using graph and tc formula I=280
Q=225400 m3 hourly peak

Run-off zone-III:
L=8.12 km
H=100m
Using graph and tc formula I=250
Q=328282.5 Hourly pe ak

Run-off zone-IV:
L=4.88 km
H=120m
Using graph and tc formula I=260
Q=51627 m3 Hourly peak

**Run-off zone-I:**
It is approximately 2.80 sq. km area in east side of proposed site area. Total 2,91,512 m3 of rain water during peak hour( 7,84,840m3 peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily at Kalna River which is seasonal water body.

From project site, there exits a pond in eastern direction at a distance of about 5 kms. However, before the pond Kalna river is flowing. In view of the same, the drainage from the airport site joins Kalna river and there will be no impact on the pond.

**Run-off zone-II:**
It is approximately 1.15 sq. km area in north, and north-west of the proposed site area.. Total 1,20,306 m3 of rain water during peak hour(3,23,906 m3 peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily at KadasiNala which further drains into Terekhol River which is seasonal water body.

**Run-off zone-III:**
It is approximately 5.07 sq. km area in west and south west of site. Total 5,27,500 m3 of rain water during peak hour( 14,20,192 m3 peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily atTerekhol River(at south west boundary of site)

**Run-off zone-IV:**
It is approximately 0.89 sq. km area in south side of site area. Total 92,543 m3 of rain water during peak hour( 2,49,154 m3 peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily at Chapora River.

Based on the above drainage pattern study, quantity of rainwater falling on unpaved area will be collected through storm water channels and sent to nearest water body. Quantity of the same is calculated and depicted in Table 5.12 b. The proposed project site is located at higher elevation, provision shall be made to route the water through channel by gravity to nearest water body.

The water falling on the paved area and buildings will be routed to rain water harvesting pits. Therefore no flooding condition shall occur after construction of the proposed airport and there will be no net effect on the downstream areas.

**Construction Phase**

**Impact Evaluation**

The impact on land environment during construction phase shall be due to generation of debris/construction material, which shall be properly collected and disposed off.

Debris will be segregated and whatever is resalable will be sold to buyers and rest of the waste will be used for filling up of low lying area and development of internal roads.

The impact on land use and topography during construction phase is summarized in **Table 5.13 a.**

**Table 5.13 a: Impact on land use & topography (construction phase)**

| Factors of assesement | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Complete land required for development of facilities is acquired on permanent basis, |
| Spatial | Low | The impact extends inside the site. |

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Temporal | Medium | the impact has a medium-term effect (1 week – 1 year) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Low** | By combining $I_t$ and Vulnerability factors |

There is potential for impact on soil quality due to project-related spills and leaks of fuel and chemicals and uncontrolled disposal of wastes and wastewater. Care will be taken to avoid spills and leaks of hazardous substances and all project-related wastes. Littering of sites and areas beyond the site will be controlled.

The impact on soil quality during construction phase is summarized in **Table 5.13 b.**

**Table 5.13 b: Impact on soil quality (construction phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| intensity | Low | Releases of low quantity |
| Spatial | Low | The impact extends inside the site. |
| Temporal | Medium | the impact has a medium-term effect (1 week – 1 year) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Low** | By combining $I_t$ and Vulnerability factors |

**Mitigation Measures**

- Avoiding rainy season for construction so as to avoid soil erosion.
- Restricting all construction activities inside the project boundary.
- Ensuring the top top-soil soil stock pile is not contaminated with any type of spills.
- Ensuring any material resulting from clearing and grading should not be deposited on approach roads, streams or ditches, which may hinder the passage and/or natural water drainage.
- Restoration of construction camp sites before abandonment.
- After final site grading is complete, ensuring that the excess excavated material is not dumped indiscriminately but used for filling low lying areas or berm construction by locals and keeping a record of the same.
- Developing project specific waste management plan and hazardous material handling plan for the construction phase.
- Providing drip trays and liners while working with hazardous liquid materials such as fuels and chemicals.
- Developing and maintaining dedicated waste storage areas, with secondary containment for hazardous wastes.

**Operation Phase**

**Impact Evaluation**

The impact on land environment during operational phase shall be due to disposal of solid waste generated during operation.

Solid waste collected during operation phase will be disposed in disposal facility owned by Government of Goa.

Hazardous waste management: From Airport, used oil, lubricants, electronic wastes shall be generated and the same shall be disposed through SPCB authorized reprocessor. Used batteries will be given to dealer as part of buy back arrangement.

The impacts on soil quality during operation phase are summarized in **Table 5.14**.

**Table 5.14: Impact on soil quality (operation phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Releases of low quantity |
| Spatial | Low | The impact extends inside the site. |
| Temporal | Medium | the impact has a medium-term effect (1 week – 1 year) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Low** | By combining $I_t$ and Vulnerability factors |

**Mitigation Measures**

- Developing and maintaining dedicated waste storage areas,
- Ensuring hazardous waste storage areas are provided with secondary containment.
- Disposing of hazardous wastes to vendors authorized by the concerned authorities.

### 5.3.4 NOISE ENVIRONMENT

**Construction Phase**

**Impact Evaluation**

The main sources of noise emissions during construction phase are operation of heavy equipment and machinery, operation of emergency power generation sets and movement of vehicles (heavy vehicles carrying materials and light vehicles carrying project related personnel).

Construction noise levels associated with typical machinery based on "BS 5228: 1997 Noise and Vibration Control on Construction and Operation Sites" are summarized in the **Table 5.15**.

**Table 5.15: Sound Pressure (noise) levels of Construction Machinery**

| Item Description | Noise Level dB(A) | Reference Distance |
|---|---|---|
| **Earth Movers** | | |
| Front Loaders | 72-84 | 0.9 m |
| Backhoes | 72-93 | " |
| Tractors | 72-96 | " |
| Scrapers, Graders | 80-93 | " |
| Pavers | 86-88 | " |
| Trucks | 82-94 | " |
| **Material Handlers** | | |
| Concrete Mixers | 75-88 | 0.9 m |
| Concrete Pumps | 81-83 | " |
| Cranes (movable) | 75-86 | " |
| Cranes (derrick) | 86-88 | " |
| **Stationary Equipment** | | |
| Pumps | 69-71 | 0.9 m |
| Generators | 71-82 | " |
| Compressors | 74-86 | " |

The impact of noise emission on ambient noise levels are summarized in **Table 5.16**:

**Table 5.16: Impact on ambient noise (construction phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Releases of low quantity |
| Spatial | Medium | Impact extends in a restricted area outside the site (< 1 km) |
| Temporal | Low | The impact has a temporary and short term effect (1 day – 1 week) |
| Vulnerability | Low | Open area |
| **Evaluation of factors** | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Vaiue of Impact (S)** | **Low** | By combining $I_t$ and Vulnerability factors |

**Mitigation Measures**

- Ensuring preventive maintenance of equipment and vehicles
- Avoiding unnecessary engine operations (e.g. equipment with intermitted use switched off when not working)
- Ensuring DG sets are provided with acoustic enclosures and exhaust mufflers
- Ensuring vehicle movement is avoided close to sensitive receptors (such as schools, hospitals, places of worship.

**Operation Phase**

**Impact Evaluation**

During operation phase of the Airport, following are the main causes of noise emission:

- Aircraft landing and taking off.
- Ground Noise

**Noise emission due to aircraft:**

Noise emission from a aircraft is caused by two things: **Airframe noise & Engine noise.**

**Airframe noise** occurs when air passes over the plane's body (the fuselage) and its wings. This causes friction and turbulence, which make a noise.

**Engine noise** is created by the sound from the moving parts of the engine, and also by the air being expelled at high speed once it has passed through the engine. Most of the engine noise comes from the exhaust or jet behind the engine as it mixes with the air around it.

Ground noise shall be due to the following sources/factors:
aircraft engine tests, airside vehicular traffic , Using reverse thrust to increase braking during landing, Planes travelling between the run-way and stands (their 'parking space'), Planes sitting on their stands with their power units running, DG Sets, pumps etc.

Transport links to an airport, particularly private vehicles and trains, can also make a significant contribution to noise around airports.
Noise emission during night time:
Many people are not bothered by aircraft noise during the day, but they can be affected at night.
The existing Goa Dhabolim Airport is allowed to operate a limited service at night. There are restrictions on the level of night time noise that is allowed and the number of planes that can fly at night.
There shall be increase in noise generation due to increase in air traffic with the operation of new international terminal.

**Noise Model:** Aircraft today are much quieter than they were in olden days and these will be replaced by even quieter aircraft in the future. But, there are more planes flying today considering the past. A software namely INM (Integrated Noise Model) is used to assess the increase in noise due to the proposed international Airport. Details of the same are described below.

The Integrated Noise Model (INM) is a computer model that evaluates aircraft noise impacts in the vicinity of airports.

The INM computer program calculates noise exposure contours in the vicinity of airports by using a large database of aircraft flight performance and acoustic data along with airport-specific user-input data. The INM graphical user interface provides a versatile, user-friendly, windows-style means for users to specify operational scenarios to be modeled and to review the noise results.

INM outputs include noise contours used in land use compatibility studies, noise impacts by aircraft on individual flight tracks, and user-defined point analysis of noise impacts.

**Inputs considered in the present study**

- Airport characteristics :
  - Runway length: 3750 m,
  - width: 60 m,
  - threshold displacement: 20 m and
  - Orientation: 95 NE- 275 SW
- Aircraft :
  - Boeing 777-200
- ❖ Approach and departure tracks in 10 km radius
- ❖ Flight operations
- ❖ Noise Metric
  - LAEQ

**Output obtained from INM**

- Noise contours (contours of equal values of a noise metric)

  Noise contours are plotted in INM considering following cases.

  (1) Aircraft Take-off from East side and landing from West side of runway.
  (2) Aircraft Take-off from North-East side and landing from South-west side of runway.
  (3) Aircraft Take-off from West side and landing from East side of runway.
  (4) Aircraft Take-off from North-west side and landing from South-east side of runway.

10 Km radius around proposed airport is considered for the purpose of noise study. The contours are provided in figure no. 5.2 to 5.5.

The anticipated noise levels obtained from the study are less than 90 dB at the runway location. The noise levels started depreciating as the aircraft moves away from the runway where as it started appreciating while landing as the aircraft approaches runway. Considering the worst scenario of human exposure to this noise level, 8 hours continuous exposure is permitted for such noise levels, which is unlikely in the airport as the noise will not be continuous considering the proposed aircraft movements.

**Figure 5.2 Aircraft Take-off from East side and landing from West side of runway (Noise model case 1)**

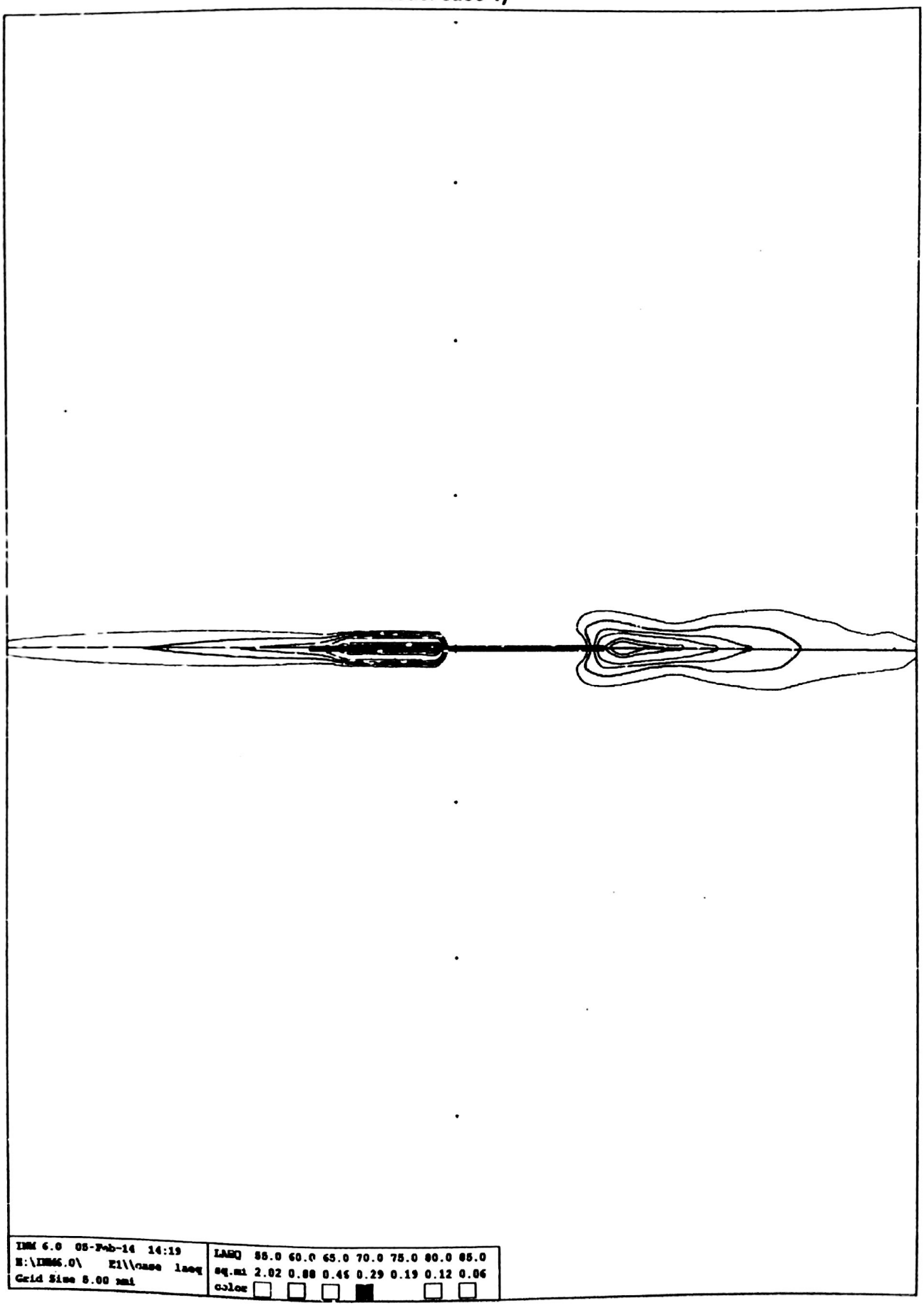


**Figure 5.3 Aircraft Take-off from North-East side and landing from South-west side of runway (Noise model case 2)**

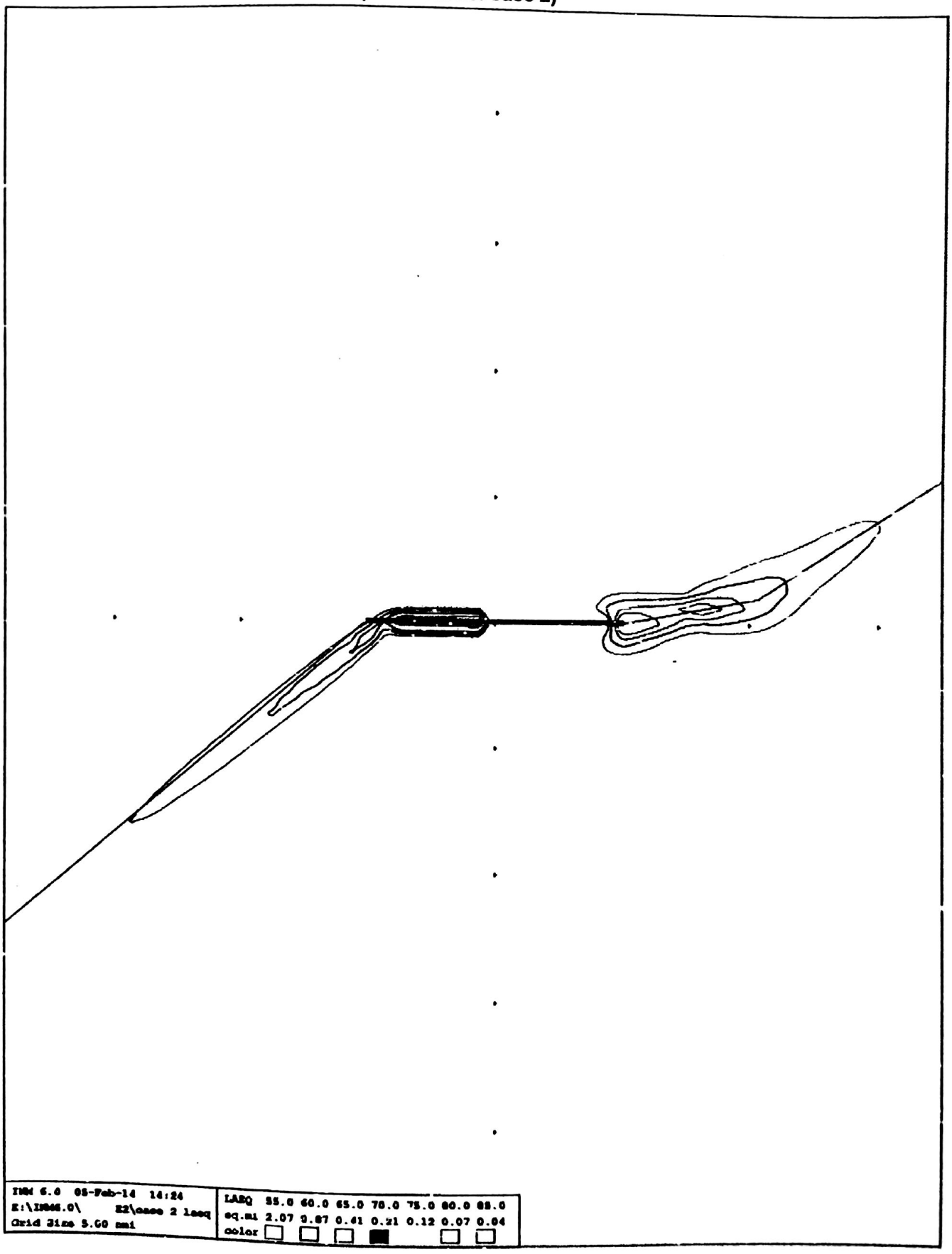


**Figure 5.4 Aircraft Take-off from West side and landing from East side of runway (Noise model case 3)**

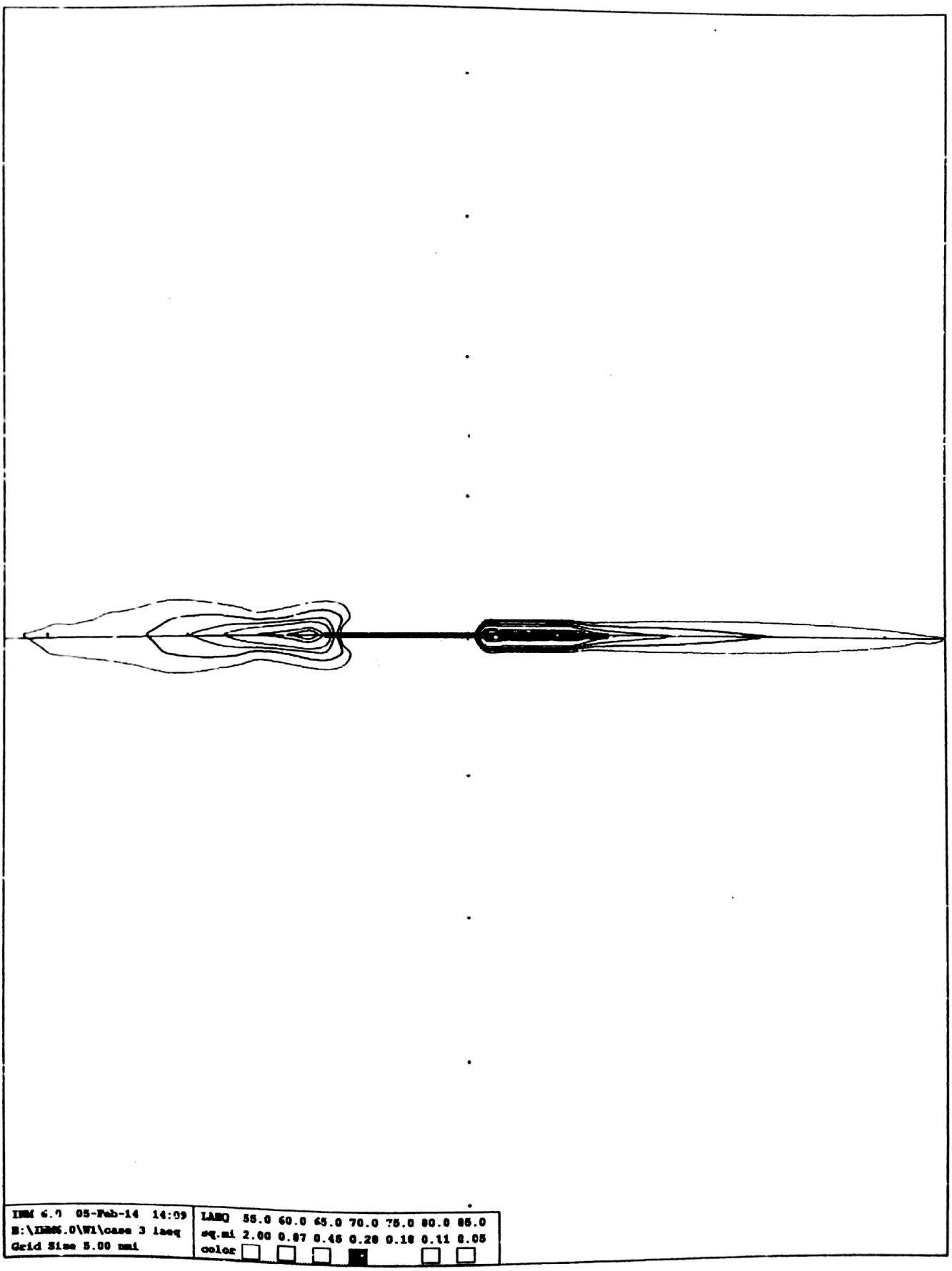
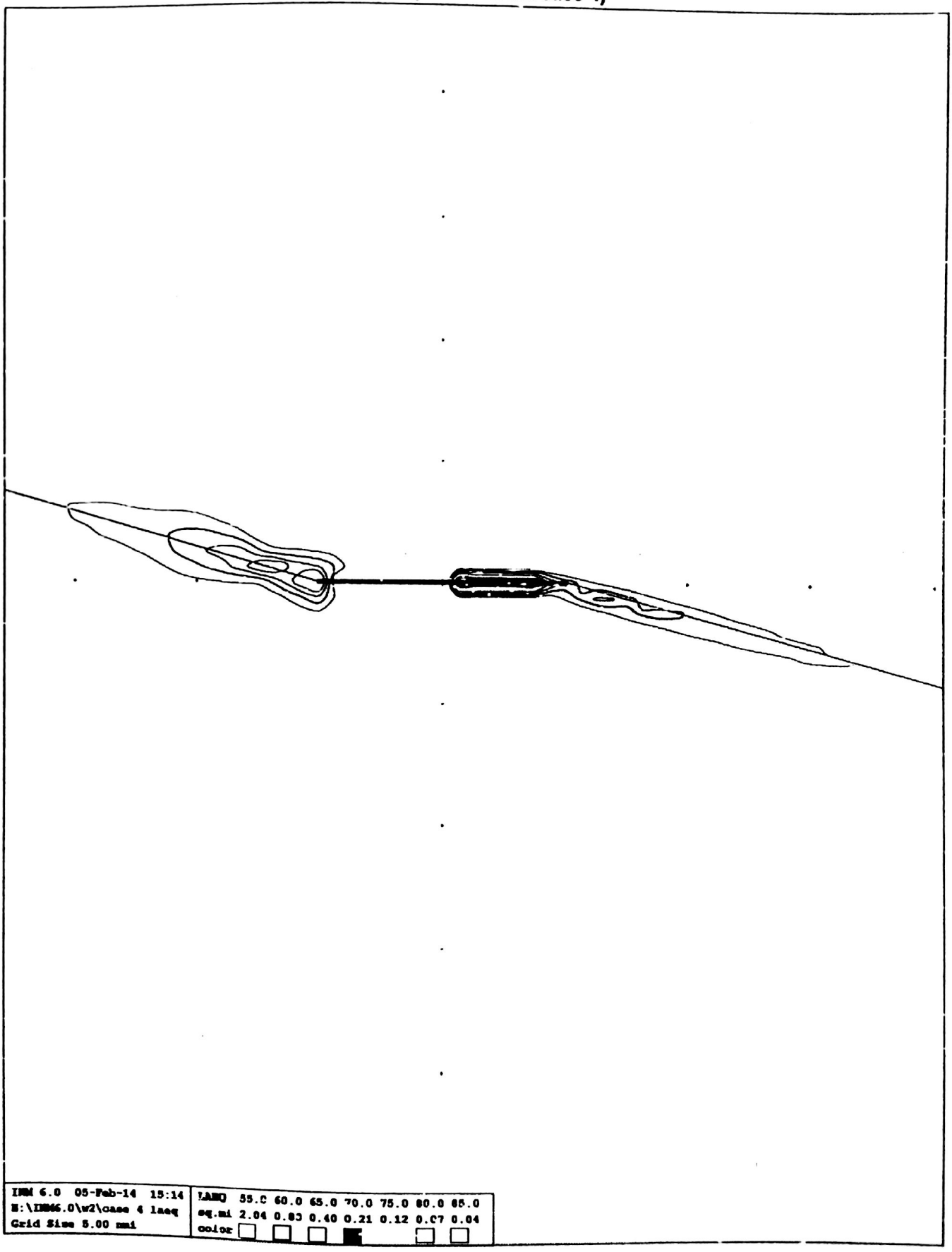


**Figure 5.5 Aircraft Take-off from North-west side and landing from South-east side of runway (Noise model case 4)**



The impact of these noise emissions during operation is summarized in **Table 5.17**.

**Table 5.17: Impact on ambient noise (operation phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Releases of low quantity |
| Spatial | Low | The impact extends inside the site. |
| Temporal | High | The impact has an important and long term effect (1 – 5 years) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Medium | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Medium** | By combining $I_t$ and Vulnerability factors |

**Mitigation Measures**

- Avoiding continuous (more than 8 hrs) exposure of workers to high noise areas.
- Provision of ear muffs at the high noise areas
- Ensuring preventive maintenance of equipment.
- Ensuring DG sets have acoustic enclosures and exhaust mufflers as per design.
- On top of the quota system, there is also an absolute limit on the number of flights permitted at the airport. Under the quota system, the airport has a total number of 'quota points', which are then used up by night time flights. Different types of planes use up different numbers of points, depending on how noisy they are.
- The noisiest aircraft use 16 points of the quota, and they're called QC16s (QC = Quota Count). The next noisiest have eight points – QC8s. As planes get quieter, their points get smaller until the quietest planes have just half a point or are exempt altogether.
- During the night quota period the noisiest types of planes are not permitted to be scheduled. Because there is a limit on the airport's total quota of points for night-time flying, this system encourages airlines who want to fly at night to use the quietest aircraft.
- Pilots are encouraged not to use reverse thrust between 23:00 and 06:00 except in the interests of safety.
- Planes shall be plugged into the mains electrical supply while they are on stand. This is a system known as Fixed Electrical Ground Power (FEGP) to replace the noisy auxiliary power units (APU) on the plane itself. It allows things like interior lighting and the air conditioning systems to operate.
- Above all, the proposed Mopa Airport is located in mountain top and is mostly far from the habitations. Hence, there will be less impact due to noise on the habitations.

**IMPACT DUE TO TRAFFIC**

**Construction phase**

The impact on noise environment during the construction phase of the proposed Aiport shall be due to movement of quarrying and borrow material, construion material and movement of construction workers etc.

## Design & operation phase

### Traffic – Road

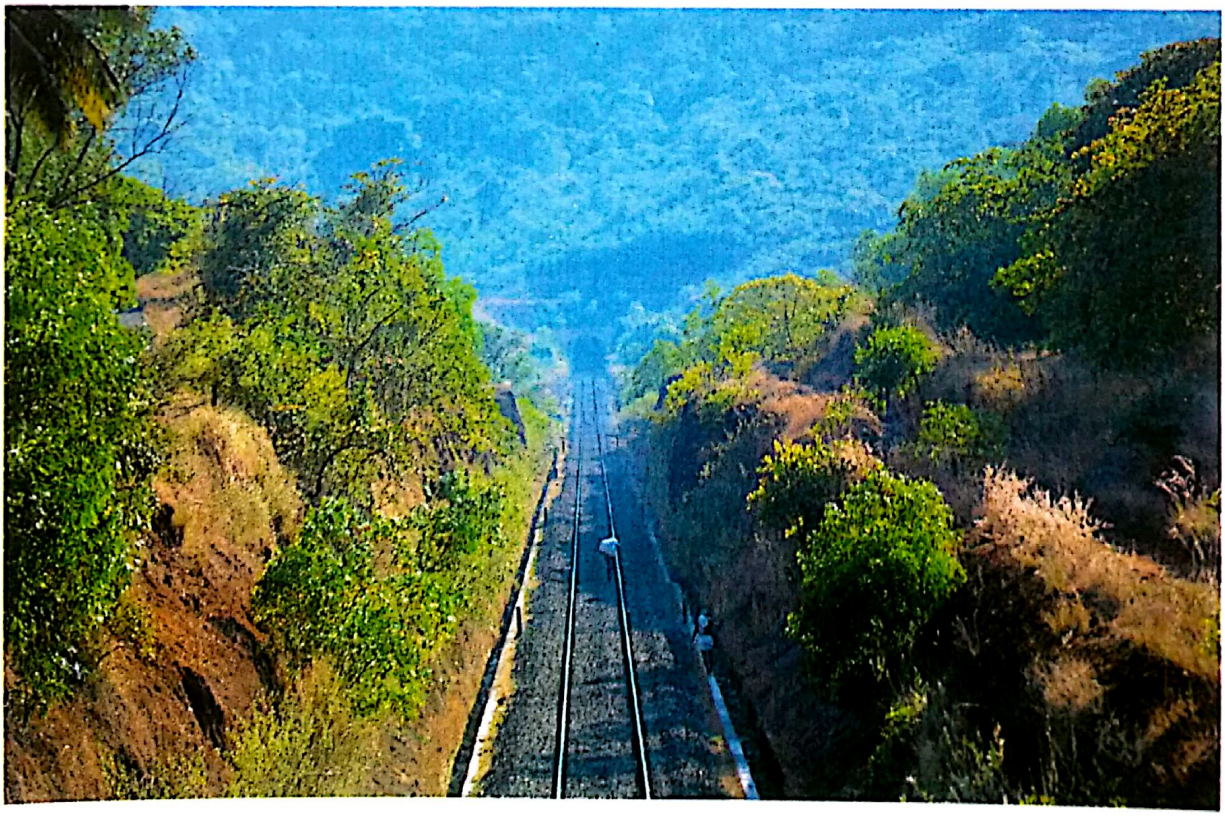
The main connecting habitation places to the project site is are NH 17. Traffic is counted for Heavy, Medium and Light vehicles on these connecting road to project site.

It is to be noted that the increase due to the proposed Aiport activities and there shall be an increase in vehicles upto 100 per day. All proper traffic management measures will be adopted towards reduction in movement of vehicles. This shall lead to optimum carbon foot print. There shall not be an increase in linear proportions over a long run period. Also adequate funds will be allocated towards implementation of traffic management measures on these roads as a Corporate Social Responsibility.

### Traffic – Rail

The most common, preferred and presently used route is by road. The alternate route is by Train. Konkan Railway line is facilitating connections to all major industrial towns and population centres at Goa. There will be additional load on the rail network due to the proposed project activities and passenger travel from South Goa to reach the Airport.

**Figure 5.6: Konkan Railway line**



### Traffic – Water

The another option shall be by inland waterways. But there will be no additional load on the inland water network due to the proposed Airport.

**Traffic – Air**

The airport is located about 35 km from the capital of Goa-Panaji. Some of the major towns and villages within the study area are

Accordingly, there will be additional load on the air network which will be met from the proposed International Airport at Goa.

### 5.3.5 BIOLOGICAL ENVIRONMENT

**Construction Phase**

**Impact Evaluation**

The area acquired for proposed airport have only few trees but mainly bushes. These will be cleared during site preparation. Open pipeline trench and un-barricaded waste/waste water pits may lead to injury of animals which fall in them.

The impacts on flora and fauna during construction phase are summarized in **Table 5.18.**

**Table 5.18: Impact on Biological Environment (construction phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | High | Felling of trees |
| Spatial | Medium | Impact extends in a restricted area outside the site (< 1 km) |
| Temporal | High | The impact has an important and long term effect (1 – 5 years) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | High | By combining intensity and spatial factors |
| Impact($I_t$) | High | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Medium** | By combining $I_t$ and Vulnerability factors |

**Mitigation measures**

- Keeping a tally of trees cut – viz. no., species taluka-wise.
- Avoid cutting of tress wherever possible, especially the endangered species observed in the study area.
- Exploring opportunities for conservation of endangered species.
- Closing of trenches as soon as possible of construction.
- Hard barricading of hydrotest water disposal pits.
- Prevent littering of work sites with wastes, especially plastic and hazardous waste.
- Training of drivers to maintain speed limits and avoid road-kills.

**Operation Phase**

**Impact Evaluation**

The movement of operation related vehicles may result in road kills of animals.

The impacts on flora and fauna during construction phase are summarized in **Table 5.19**.

**Table 5.19: Impact on Biological Environment (operation phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| intensity | Low | Releases of low quantity |
| Spatial | Medium | Impact extends in a restricted area outside the site (< 1 km) |
| Temporal | High | Impact has an important and long term effect (1 – 5 years) |
| Vulnerability | Low | Open area |
| Evaluation of factors | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Medium | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Medium** | By combining $I_t$ and Vulnerability factors |

**Mitigation Measures**

- Keeping a tally of trees cut – viz. no., species taluka-wise
- Avoid cutting of tress wherever possible
- Training of drivers to maintain speed limits and avoid road-kills

## 5.3.6 SOCIO ECONOMIC ENVIRONMENT

**Construction Phase**

**Impact Evaluation**

The impact on socio-economic environment during construction phase shall be due to acquisition of land for the project and the rehabilitation & relocation of households for the same.

In the construction phase an influx of construction workers will have impact on some people, as the demand for goods and services in the area would increase. This impact can be negative in the short run but in the long term the impacts are reversible in nature and may lead to growth of overall infrastructure and commercial activities in the study area. Moreover, the project affected people would be rehabilitated by Government of Goa. Over the period of time, there shall be positive impact with better connectivity and transport facilities.

There will be increase in employment opportunities with impetus for skilled jobs both from the project and the new international terminal along with secondary and tertiary sector services/ businesses. Further, both traffic congestion and distance to travel to reach new airport shall be less due to connectivity to existing highway and the proposed approach

road, which would also bring business opportunities for transport services. Aggregative there shall be positive impact on socio-economic environment due to development of infrastructure in the area, growth of secondary and tertiary sector businesses and subsequent enhancement in the standards of living of the local populace.

The impact of construction activities on socio-economic environment during construction phase is summarized in **Table 5.20**:

**Table 5.20: Impact on Socio-Economic Environment (construction phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Involvement of labour, infrastructure and other utilities in marginal quantities/Nos. |
| Spatial | Medium | Impact extends in a restricted area outside the site (< 1 km) |
| Temporal | Medium | The impact has an medium term effect (1 week – 1 year) |
| Vulnerability | Low | Open area |
| **Evaluation of factors** | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact(S)** | Low | By combining $I_t$ and Vulnerability factors |

**Rehabilitation & Resettlement**

Government of Goa is the owner of the Mopa Airport land. All the compensation awards have been finalized and passed and the entire compensation amount of Rs. 54.79 crore has been placed with Economic Development Corporation, the disbursing agency for the release of claims. The Government of Goa will suitably consider rehabilitation and resettlement if some families are to be relocated.

**Mitigation Measures**

- Ensuring early payment of compensation
- Training contractors on company road safety policy requirements
- Monitoring speed and route of project-related vehicles
- Determine of the safe, legal load limits of all bridges and roads that will be used by heavy vehicles and machinery.
- Determining allowable traffic patterns in the affected area throughout the work week will be made based on community use, include a consideration of the large turning requirements of certain vehicles/machineries that might increase congestion and traffic hazards
- Upgrading local roads, wherever required, to ensure ease of project activity and community safety
- Consolidating deliveries of materials and personnel to project sites, whenever feasible, to minimize flow of traffic
- Minimizing interruption of access to community use of public infrastructure
- Providing prior notice to affected parties when their access will be blocked, even temporarily.
- Returning all roads to a passable condition before the end of each working day
- Monitoring construction camp safety and hygiene
- Preventing use of drugs and alcohol in project-sites

- Preventing possession of firearms by project-personnel, except those responsible for security
- Ensuring project-related waste and wastewater is disposed in a responsible manner

**Operation Phase**

**Impact Evaluation**

There will be increase in employment opportunities with impetus for skilled jobs both from the project and the new international terminal along with secondary and tertiary sector services/ businesses. Further, both traffic congestion and distance to travel to reach new airport shall be less due to connectivity to existing highway and the proposed approach road, which would also bring business opportunities for transport services. Aggregative there shall be positive impact on socio-economic environment due to development of infrastructure in the area, growth of secondary and tertiary sector businesses and subsequent enhancement in the standards of living of the local populace.

The impact of these activities on socio-economic environment during operation phase is summarized in **Table 5.21**:

**Table 5.21: Impact on Socio-Economic Environment (operation phase)**

| Factors of assessment | Value of assessment | Justification |
|---|---|---|
| Intensity | Low | Involvement of labour, infrastructure and other utilities in marginal quantities/Nos. |
| Spatial | Medium | Impact extends in a restricted area outside the site (< 1 km) |
| Temporal | Medium | The Impact has an medium term effect (1 week – 1 year) |
| Vulnerability | Low | Open area |
| **Evaluation of factors** | | |
| Impact($I_s$) | Low | By combining intensity and spatial factors |
| Impact($I_t$) | Low | By combining $I_s$ and temporal factors |
| **Overall Significance Value of Impact (S)** | **Low** | By combining $I_t$ and Vulnerability factors |

**Mitigation Measures**

- Extending pipeline safety awareness campaigns in new project areas
- Monitoring speed and route of project-related vehicles

## 5.4 SUMMARY OF IMPACT EVALUATION

Based on the above evaluation the significance value of impact on various components of environment during construction and operation phases is summarized and is given in **Table 5.22**.

**Table 5.22: Summary of Impact Evaluation in terms of Significance Value**

| Environmental component | | Construction | Operation |
|---|---|---|---|
| Air | | Low | Medium |
| Water | Consumption of Raw Water | Medium | Medium |
| | Generation of Effluent | Low | Low |
| Land | Land use & Topography | Low | - |
| | Soil Quality | Low | Low |
| Noise | | Low | Medium |
| Biological | | Medium | Medium |
| Socio-Economic | | Low | Low |

# CHAPTER 6

# ENVIRONMENTAL MONITORING PLAN

## 6.0 INTRODUCTION

Regular monitoring of environmental parameters is of immense importance to assess the status of environment during project operations. With the knowledge of baseline conditions, the monitoring programmed will serve as an indicator for any deterioration in environmental conditions due to operation of the project, to enable taking up suitable mitigation steps in time to safeguard the environment. Monitoring is as important as that of pollution since the efficiency of control measures can only be determined by monitoring.

Usually, as in the case of the study, an impact assessment study is carried out over short period of time and the data cannot bring out all variations induced by the natural or human activities. Therefore, regular monitoring programme of the environmental parameters is essential to take into acccunt the changes in the environmental quality.

## 6.1 ENVIRONMENTAL MONITORING

### 6.1.1 AMBIENT AIR QUALITY

Ambient air quality shall be monitored for $NO_x$ and SPM around the premises of the airport. The proposed monitoring program for the field monitoring and laboratory analysis of air is given in the following table 6.1

**Table 6.1 Proposed monitoring programme (Air)**

| Monitoring | Parameters to be monitored | Monitoring location/site | Sampling duration | Frequency | Method of monitoring |
|---|---|---|---|---|---|
| Ambient air quality | $NO_x$ and SPM | Locations around the premises* | Twice a week, 4 weeks in a season | Seasonal | As per CPCB standards for NAAQM, 1994 |

- Monitoring locations to be finalised in consultation with State Pollution Control Board

### 6.1.2 NOISE LEVELS

Ambient Noise levels shall be monitored around the premises of the airport, near DG sets and at the main entrance/boundary of airport. The proposed monitoring programme for the Ambient noise levels is given in the following Table 6.2

**Table 6.2 Proposed monitoring programme (Noise)**

| Monitoring | Parameters to be monitored | Monitoring location/ site | Sampling duration | Frequency | Method of monitoring |
|---|---|---|---|---|---|
| Ambient Noise levels | Noise levels in dB(A) | Near the airport site, main entrance, near DG sets | Once a week | Weekly | Instrument: Noise level meter IS: 4954-1968 as adopted by CPCB |

### 6.1.3 WATER QUALITY

Water quality parameters shall be for one year before and for at least three years after completion of the proposed expansion project. Monitoring shall be carried out at least four times a year to cover seasonal variations. Water quality shall be analysed by the standard technique (IS:2488, Standard methods American Public Health Association (APHA)). The parameters for monitoring would be:

PH, Dissolved oxygen, BOD,COD, Total coliform count, TDS, Temperature, Total Hardness, Calcium, Magnesium, Iron, Manganese, Chlorides, Sulphates, Nitrates, Fluorides, Mercury, Cadmium, Arsenic, Cyanides, Lead, Zinc, Total Nitrogen and Phosphates

The monitoring points shall be bore wells of airport and treated STP water at discharge point.

### 6.1.4 SOIL CONSERVATION

Soil erosion rates, slope stability of land faces, effectiveness of soil conservation measures, change in soil texture and structure should be monitored at frequent intervals.

# CHAPTER 7

# ADDITIONAL STUDIES

M/s Engineers India Limited (EIL) has been engaged by M/s Government of Goa for conducting the Disaster Management Plan (DMP) of proposed Greenfield airport at Mopa, Goa.
Disaster management plan has been attached as Annexure VI.

# CHAPTER 8

# PROJECT BENEFITS

## 8.0 INTRODUCTION:

It has been observed that the airports and especially International airports have become the catalysts for local economic development. Experts in the field are of the opinion that airports will shape business location and urban development in this century as much as seaports did in the 18th Century, railroads in the 19th Century and highways in 20th Century.
Today's airports are big business impacting the social, economic and political life and fabric of today's communities. The employment generation has two aspects i.e. direct and indirect. Direct employment is the employment attributed to the operation and management of the airport, airline operations and associated services. Indirect employment is the employment in non-aviation industries that result from airport activity. Employment generated to support direct airport related employment.
Following are the benefits of land side commercial developments.

- Source of Revenue for Airport
- Facilitates and supports development of cargo and passenger air services
- Economic Benefits to Community

Since the rise of commercial aviation during the mid-twentieth century, airports have become integral components of the economic activity of urban settings. The contribution of airports to local economic activity was traditionally oriented around their gateway for people and products, but in the last decade, the pursuit of non-aeronautical revenues has resulted in many airports leveraging their property assets to generate commercial development activity.

Tourism is Goa's primary industry: it handles 12% of all foreign tourist arrivals in India. Goa has two main tourist seasons: winter and summer. In the winter time, tourists from abroad (mainly Europe) come to Goa to enjoy the climate. In the summer time (which, in Goa, is the rainy season), tourists from across India come to spend the holidays. Goa is the smallest state with less than 2% of India's land mass- and yet it accounts for nearly 46% of all the mining leases granted nationwide. It is anticipated that the airport development will not only increase and support tourism, but also accommodate the projected growth in business travel and cargo movements in Goa.

## 8.1 INFRASTRUCTURE:

The aviation linked commercial development has been evolved around airport including Basic Amenities , shopping plaza and office parks, hospitality industry, promotional activities of tourism, logistic park and housing. Following are the envisaged development.

### 8.1.1 Roads:

The four-to-six lane express road measuring about 8 km between NH-17 and airport site is proposed. The approach road is passing from barren land and reserved forest areas. The proposed approach road crosses Konkan railway and irrigation canal near Dangal village a starting point of express highway. According to Regional Plan a growth hub is proposed near Pernem and will also be connected via 25 m wide road.

### 8.1.2 Public Amenities:

Essential amenities listed in Table 8.1 are provided as per the requirements of Airport City as per the standards and norms suggested in UDPFI norms

**Table 8.1: Public amenities areas.**

| S. No | Components | Area (Sq. m) | No. | Total area (sq. m) |
|---|---|---|---|---|
| 1. | Post Office | 200 | 1 | 200 |
| 2. | Telephone Exchange | 5000 | 1 | 5000 |
| 3. | Police Station | 1600 | 1 | 1600 |
| 4. | Conveniences | 1000 | 2 | 2000 |
| 5. | Health Center / Hospital | 10000 | 1 | 10000 |
| | Toial | | | 18,800 |

it is assumed that the public amenities would be required at the beginning of the operations of the project and hence proposed to be developed by 2020.

### 8.1.3 Hospitality and Office space:

The demand assessment for hospitality components is indicated in table 8.2:

**Table 8.2: Assessment for Hotel rooms (year-wise)**

| | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Forecast of Beds | 46,051 | 50,590 | 66,538 | 77,093 | 89,321 |
| Number of passengers per room | 2 | 2 | 2 | 2 | 2 |
| Forecast of Rooms required | 23026 | 25295 | 33269 | 38547 | 44661 |
| Gap in number of Rooms w.r.t. current availability | | 2,269 | 10,243 | 15,521 | 21,635 |
| % of Rooms may be considered at proposed Airport Project | | 10% | 10% | 10% | 10% |
| Number of Rooms | | 227 | 1024 | 1552 | 2164 |

Based on the above, total 1500 number of rooms has been considered for the proposed project. The distribution of rooms in different categories based on the current distribution of rooms in Goa and area requirements is as given in Table 8.3

**Table 8.3: Hotel area requirement**

| Category | % Distribution | Rooms (no.) | Unit area (sq. Mt) | Total area (sq. Mt) |
|---|---|---|---|---|
| 5 Star Hotel | 40% | 600 | 50 | 30,000 |
| Eco, Adventure and Wellness Resort | 20% | 300 | Lump sum | 1,500,000 |
| 3 Star / Budget Hotel | 40% | 600 | 30 | 18,000 |
| Total | 100% | 1500 | | 78,000 |

Based on the above estimates the development of hospitality components is proposed in 2 phases.

An emerging trend is the strategic placement of Factory Outlet Shops on or adjacent to airport lands in order to benefit from the regional population trade area capture, airport activity, tourists draw and highway locations that airport lands offer.

**Table 8.4: Requirement For Commercial Space**

| Particulars | Unit | Area required Sq. Mt | Total built up Sq. Mt |
|---|---|---|---|
| Shopping plaza and office spaces | 200 shops<br>250 offices | 40X 200 = 8000<br>40X 250 = 10000 | 38000 |
| | Mall | 20000 | |

The above office space also includes the office space for Airline office. Based on the above estimates the development of shopping mall and plaza is proposed in 2 phases. The ultimate capacity of may be provided by 2025.

### 8.1.4 Visitor's centre and Convention centre:

The visitor centre has been proposed to provide services to passengers, airport employees, and meeters and greeters such as leisure, entertainment, and cultural venues. It is a place for tourists to have a quick glance and exposer to Goa's art and crafts, culture and tradition. Broadly the following activities are envisaged in the Visitors Centre.

a. Information desks and kiosks
b. Tourist facilities, rest rooms
c. Conference area
d. Café and recreation
e. Display of art and craft of Goa
f. Indoor and outdoor exhibition space.
g. Cultural centre and museum
h. Amphitheatre
i. Open Exhibition ground

The activity wise area statement is worked out as follows (table 8.5):

**Table 8.5: Visitors Center Area Requirement**

| No. | Particular | Area in Sq. Mt. | No. | Area |
|---|---|---|---|---|
| 1 | Reception, waiting lounge and foyer | 15mt X15mt = 225 | 1 | 225 |
| 2 | VIP lounge with washroom | 10mt X 10 mt.=100 | 1 | 100 |
| 3 | Admin with general storage area | 10mt X 10mt = 100 | 1 | 100 |
| 4 | Rest rooms | 5mt X 4 mt =20 | 30 | 600 |
| 5 | Conference area for 50 people | 50 person X 3 sqmt=150 | 3 | 450 |
| 6 | Café + kitchen | 20mt X 20mt =400 | 1 | 400 |
| 7 | Information desks and Kiosks | 15mt X 15mt = 225 | 1 | 225 |
| 8 | Indoor exhibition space | 25mt X 15mt = 625 | 1 | 625 |
| 9 | Cultural Museum | 20mt X 20mt =400 | | 400 |
| 10 | Auditorium for 500 capacity | 500 person X 3mt. | 1 | 1500 |
| 11 | Library | 20mt X 20mt =400 | 1 | 400 |
| 12 | Art and Craft workshop and display area | 20mt X 20mt =400 | 1 | 400 |
| 13 | Recreation club | 30mt X 30mt=900 | | 900 |
| | | Total area | | 6325 |
| | | Add 15 % passage area | | 950 |
| | | Add 10% service area | | 632 |
| | | Add 10% structure area | | 632 |
| | | **Total of built up** | | **8540** |
| 14 | Open exhibition ground | | | **5 0,000** |
| | | **Grand Total of Area** | | **5.85 Ha.** |

**Convention centre:**

The Indian Convention Industry is currently at a nascent stage, contributing only a small proportion of the world conventions business. In terms of number of meetings, India has a share of 1% and in terms of delegate arrivals/ participation, 0.7% of the world figures.

As per the study conducted by Ministry of Tourism, the conventions/conference market is estimated at Rs. 4,000-5,500 crores annually. The entire tourism sector accounts for 2.2 percent of GDP (2005 estimates) of which conventions tourism contributes around 5-7 percent of total tourism revenues, comparable to that in other convention destinations but small in terms of India's potential. Conferences and tradeshows are the most important categories of events. A few venues account for the bulk of events and certain sectors such as the medical and pharmaceutical industries predominate. Participation is largely domestic and there is considerable seasonality in the conventions industry.

India is at an inflection point as far as the conventions and conferences business is concerned. With the emergence of India as a key economic hotspot along with China, and the country's recent tourism boom (with an increase in inbound travel from several international destinations for leisure, business and medical tourism), convention tourism has enormous possibilities in the country. India is growing strength in the Information Technology arena, as well the booming civilian Airlines industry has prompted prominent international bodies to host trade shows and conventions in the country and similar prominence in the bio-technology area and manufacturing sector is also expected to bring convention revenues to the country in the coming years.

Four metro cities (New Delhi, Mumbai, Kolkata, Chennai) and 6 other locations (Bangalore, Hyderabad, Kochi, Agra, Jaipur and Goa) account for more than 70% of all conventions held in India.

Convention Facilities in Goa:

The International Convention Centre at Panaji, caters to the growing need for a proper convention facility in this city/ state. Currently, the Hotels having conference facilities are Fort Aguada Beach Resort, The Leela Goa, Majorda Beach Resort, Cidade De Goa, Part Hyatt Goa Resort and Spa, Goa Marriott Resort, Taj Exotica Goa etc. Most of these hotels have capacities for 300-450 delegates.

Proposed Convention Center:

Based on the above it is proposed to develop convention facility of 1000 delegates over an area of 5 ha. Apart from the main hall of 1000 capacity, smaller break-out rooms/meeting rooms (1 room of 100 pax, 2 rooms of 50 pax and 2 rooms of 30 pax) have also been proposed.

The convention center has good revenue potential and Goa is one of the most appropriate destinations of India for such facilities. Hence it is proposed to develop the convention center of 1000 delegates' capacity by 2025.

### 8.1.5 Residential Township:

The airport activates as well as associated commercial activities will generate employments in turn housing need for the people. Ultimate area required for staff housing is 0.8 Ha.

### 8.1.6 Logistic Facilities:

The logistics facilities are proposed to be located in the proximity to the Cargo Terminal /Hangers to have shortest distance and smooth flow of goods. It is also provided away from other commercial activities like hotels, shopping plaza, office space, visitors and convention centre to avoid traffic disturbances generated by the goods movements.

The Key Success Factors of providing Air Cargo Facilities are listed below. The planning has been done considering these factors.

a. Identification of a viable market

b. Highly focused positioning strategy

c. Geographic Proximity to Demand

d. Efficient Airside Infrastructure

e. Efficient Cargo Handling Facilities

f. Effective Ground Handling Equipment

g. Smooth Customs Clearance

h. Efficient Road Access

The proposed complex for logistic facility would include following activities:

a. logistic operators offices

b. custom clearing offices

c. Warehouses

d. Cold storages

e. packaging centre

f. Truck parking, drivers facilities, petrol pumps and other support services

Demand Assessment and Component Sizing:

- As per the UDPFI norms the land requirement is 1 ha Per 300 Tones of daily goods inflow into the complex.
- It is estimated that by the year 2045 total cargo handled would be 41406 Tones per annum
- Assuming 3 days cycle for the cargo the storage space requirement by the year 2045 would be 1 ha.
- Considering the UDPFI norms the components and area requirements are as follows :

**Table 8.6: Logistics facility program**

| Use | Percentage Area (as per UDPFI Norms) | 2020 | 2025 | 2035 | 2045 |
|---|---|---|---|---|---|
| Transport operators office , godowns etc | 30 % | 0.45 | 0.6 | 0.8 | 1.5 |
| Service industry petrol pump | 6 % | 0.40 | 0.5 | 0.8 | 1.2 |
| Public /semi public police post, post office, telephone, first aid etc. | 3% | 0.35 | 0.45 | 0.80 | 1.2 |
| Government Offices | 3% | 0.35 | 0.45 | 0.80 | 1.2 |
| Parking | 18% | 0.40 | 0.50 | 0.80 | 1.35 |
| Open spaces | 10% | 0.40 | 0.50 | 0.80 | 1.25 |
| Circulation | 28% | 0.45 | 0.55 | 0.80 | 1.45 |
| Others | 2% | 0.35 | 0.45 | 0.80 | 1.15 |
| Total | 100% | 3.15 | 4.00 | 6.40 | 10.3 |
| **Total Area Requirement (including Storage Space (ha)** | | **3.00** | **4.35** | **7.12** | **11.43** |

Total Area Requirement would be: Storage Space + other components

1.13 ha + 10.3 ha

11.43 ha

T Say 12 ha

he total area required for Public amenities, Hotels, Shopping mall, Visitor's centre, Exhibition ground, convention centre, residential centre and logistic facilities will be 53.43 ha

# CHAPTER 9

# ENVIRONMENTAL COST BENEFIT ANALYSIS

## 9.0 ENVIRONMENTAL COST BENEFIT ANALYSIS

Finally, before the construction of new International Airport started, we also have to look at the cost benefit analysis.

## 9.1 INTERNAL RATES OF RETURN

It is expected by the development of new airport will give economic return to the state. By encouraging more investors and tourists throughout the world come to Goa, it is belief it will increase the demand for local industries especially in hotel and resorts, restaurants and so forth as the new interesting place to visit. A large postion of investment is required to develop this airport. Therefore, the margin rate of return also should be high.

## 9.2 ECONOMIC BENEFITS

The new airport also will give economic benefit to the state. According to economic analyst, the major benefits will be (i) incremental net visitor expenditures, (ii) time savings of passengers, and (iii) the value of foregone passenger and cargo traffic. Besides that, the cost savings in domestic aircraft operation and time landed in the airport will also included in the analysis.

## 9.3 PROJECT COSTS

The allocation of the project cost will be approved by the government. This cost includes the following:

(i) civil works,
(ii) construction
(iii) equipment and its installation, and
(iv) consulting engineering design and supervision.

Besides that, the abatement cost also should take into consideration in order to reduce the pollution which will harm the community and human beings.

## 9.4 MONITORING AND REPORTING COSTS

During the construction period, the monitoring process should be required in order to make sure that the construction of the airport is according to the schedule and the quality of the building is according to the world standard. Therefore, it will incur some cost that should be borne by the contractor. The minor cost of the equipment required for monitoring environmental impacts is also included in the project cost.

## 9.5 NONQUANTIFIED ENVIRONMENTAL IMPACTS

The construction of the new airport also will produce the non quantified environmental impacts from airport development and increased other development off-site, including noise pollution, air pollution, and surface water pollution, were considered marginal, and additional economic assessment. Therefore, as mentioned earlier, the abatement cost also should be included in the project cost.

# CHAPTER 10

# ENVIRONMENTAL MANAGEMENT PLAN

## 10.0 ENVIRONMENT MANAGEMENT

Environmental Management Plan (EMP) is planning and implementation of various pollution abatement for any proposed project. The EMP lists out all these measures not only for the operational phase of the plant but also for the construction phase and planning phase. The EMP is prepared keeping in view all possible strategies oriented towards impact minimisation.

The EMP for the proposed project is divided into two phases i.e. Construction and Operational phase. The construction and operational phase details out the control/abatement measures to be adopted during these phases.

## 10.1 CONSTRUCTION PHASE

The overall impact of the pollution on the environment during construction phase is localised in nature and is for a short period. However, the control of Environmental pollution during construction phase even though for a shorter period is of vital importance. The required mitigatory measures with complete details have been considered. In order to develop effective mitigatory measures, it is important to conceive the specific activities during construction phase causing environmental pollution.

The following subsections describe the mitigatory measures to be taken for controlling the pollution/disturbance of the environment during construction phase.

### 10.1.1 AIR QUALITY

The suspended particulate pollution generated during transportation will be mitigated by proper planning of bringing the construction material, to avoid traffic disturbances and dust generation. Any significant dust generation activities shall be carried out in night time as possible.

### 10.1.2 NOISE QUALITY

Noise emissions from construction equipment will be kept to a minimum by regular maintenance. Heavy and noisy construction work will be avoided during night time.

### 10.1.3 WATER QUALITY

The drinking and sanitation facilities will be provided to the construction workforce. This is necessary to reduce pollution of any receiving water body and also to prevent hazards due to water borne vectors. Potable water shall be provided to the workers.

### 10.1.4 SOCIO ECONOMIC

- Local population is to be employed to the extent possible.
- Adequate facilities, such as water supply and sanitation, are to be provided to the labourers.
- Timely off-loading of trucks (construction materials) is to be ensured to minimize their waiting period.

### 10.1.5 LAND ENVIRONMENT

For the construction of buildings and other structures following building material are proposed. These building materials with low carbon foot print and very low embodied energy in use shall be promoted for building material apart from quarrying material.

a) Industrial waste fly ash can be used as alternative construction material. Fly ash has the properties of cement and very low embodied energy is used. in combination with cements. Fly ash can be use in building blocks, reinforce concrete also in plaster and masonry.

b) Pre-cast hollow concrete blocks: These are manufactured using lean cement concrete mixes and extruded through block-making machines of egg laying or static, type, need lesser cement mortar and enable speedy construction as compared to brick masonry; the cavity in the blocks provide better thermal insulation, and also do not need external/internal plastering.

c) Pre-cast stone blocks: Pre-cast stone blocks are of larger size than normal bricks. These are manufactured by using waste stone pieces of various sizes with lean cement concrete and enable a rationalized use of locally available materials. This saves cement, reduces thickness of stone walls, and eliminates the use of plasters on internal/external surface. Use native or quarried stone where available within the delivery radius <100–150 kms, which has a very low-embodied energy content, negligible transport energy costs, and needs only shaping. Light weight stone, which is made from cement and recycled aggregates or furnace clinkers, can also be a resourceful option.

d) Perforated brick masonry: Perforated brick masonry comprises of high strength hollow bricks with perforations of 50%–60%. These perforations act as sound and heat insulators and provide considerable savings in materials.

e) Stabilized compressed earth blocks: These blocks are made up of mud stabilized with 5% cement lime and compacted in block-making machines with no burning. The soil to be used for the blocks should have the requisite component of clay, silt, and sand. Soil-stabilized hollow and interlocking blocks can provide better thermal insulation

f) Composite ferrocement system: This system is simple to construct and made of ferrocement, that is, rich mortar reinforced with chicken and welded wire mesh. This system reduces thickness of the wall and allows larger carpet area. Pre-cast ferrocement units in trough shape are integrated with RCC columns. Ferro cement units serve as a permanent skin unit and a diagonal strut between columns. Inside cladding can be done with mud blocks or any locally viable material.

g) Alternatively, rapidly renewable materials/products, which are made from small diameter trees and fast growing low utilized species harvested within a 10 year cycle or shorter such as bamboo, rubber, eucrasia, eucalyptus, poplar, jute/cotton stalks, and so on. Rubber trees are grown to harvest rubber and at the end of their useful life, they are cut down. Thus, rubber tree wood can be utilized as a substitute for other woods. Bamboo is a rapidly renewable plant, which grows in 4–7 years. Thus, products made from bamboo can also be utilized. These products include engineered products, bamboo ply boards, rubber, jute stalk boards, and so on.

h) Composite wood products such as hardboards, block boards, lumber-core plywood, veneered Panels, particleboards, medium/low density fiberboards made from recycled

wood scrap from sawmill dusts or furniture industry bonded with glue or resin under heat and pressure, can also be used as low-energy finishes in interiors/partition walls.

i) Products, which utilize industrial waste such as wood waste, agricultural waste, and natural fibres like sisal, coir, and glass fibre in inorganic matrices like gypsum, cement, and other binders such as fibrous gypsum plaster boards etc. can also be used.

j) Products, which use recycled materials like glass, crushed stone and other waste, such as terrazzo or which are resource efficient finishes such as finished concrete flooring, ceiling tiles, and ceramic tiles are useful.

Gypsum board partitions use 92% gypsum, which can either be sourced naturally or is produced as a by-product of power plants. Thus, gypsum used for partitions can contain 100% postindustrial recycled content. Gypsum has high recyclability potential as well

## 10.2 OPERATION PHASE

It is envisaged that with strict adherence to the pollution prevention and control measures during the design stage of the complex, the environmental impacts could be moderated to the minimum possible level during the operation phase.

The environmental management plan during the operational phase shall therefore be directed towards the following :

- Ensuring the operation of aircrafts as per specified international aviation standards.
- Strict adherence to maintenance schedule for various machinery/equipment.
- Good House keeping practices.
- Post project environmental monitoring.

The following subsections discuss in brief the management plan for individual components of environment.

### 10.2.1 AIR ENVIRONMENT

**In-plant Control Measures**

Some of the important operational measures which can reduce the impact on air environment are as follows:

- Movement of cargo buses, passenger buses and other vehicles to be planned properly to reduce vehicular emissions.
- Scheduling of aircrafts to have minimum number of cars in the parking to be carried out.

**Ambient Air Quality Monitoring**

At present ambient air quality at the airport and the surrounding area is measured on continuous/periodic basis with six number of monitoring stations. The pollutants monitored are SPM, RPM, $SO_2$, $NO_x$, CO and HC. The monitoring of these pollutants will be continued in future also, on periodic basis.

**DG set stack height**

Minimum stack height shall be provided as per CPCB guidelines.

### 10.2.2 NOISE ENVIRONMENT

Proper management and allocation of aircrafts stopping areas is to be carried out to avoid noise disturbances to staff for cleaning and maintaining the aircrafts. Also at present noise monitoring is carried out at seven locations which shall be continued in future also, on periodic basis.
Following measures are adopted in the design of airport buildings to reduce impact of the noise in operation phase:

- The terminal building shall be provided with sound absorbing material such as acoustical tile, carpets and drapes placed on ceiling floor or wall surface.
- Provision of adequate provisions at the airport to allow aircrafts to avoid over running on auxiliary power units during turn around time.
- DG sets shall be provided with acoustic enclosure
- Noise levels shall be monitored continuously.

### 10.2.3 WATER ENVIRONMENT

Rainwater harvesting and drainage pattern study have been done in the project site area. The details of the same have been described in section 5.3.2 and section 5.3.3 of chapter 5.

The wastewater generated at the new international terminal shall be collected and treated and reused in irrigation of landscape/gardening, flushing of urinals and toilets.

### 10.2.4 SOCIO-ECONOMIC ENVIRONMENT

Expansion of air port will have positive impacts such as increase in tourism, transportation, communication, employment generation, and revenue income to state government. The local population is to be given opportunities afforded by the increased economic activities in the area.

**Energy Conservation measures**

Properly implemented energy saving measures may reduce considerable amount of expenditure and emission of green house gases. Various measures have been envisaged in the Project area to conserve energy.

The suggested measures are as follows:

a) Use of CFL/LED.
b) Use of Low-pressure sodium lamps for outdoor lighting along the road and security lighting with Solar Street Lights mix.
c) Solar lighting will be provided in the main control room and in areas where safety related equipment are located.
d) Use of solar water heaters for hospital, guest house.
e) Automatic timing control mechanism will be incorporated in the street lighting to save energy. Mechanism will involve staggering of on-off sequence of street lights.
f) Designing the structures having proper ventilation and natural light.
g) The hostels, guest house, hospital etc. shall have solar water heating systems. The street lights shall have 20% mix of solar lights.

h) The street lighting shall be controlled by staggering of putting on-off of lights in particular sequence.

**Use of Renewable and Alternate Source of Energy**

A detailed survey of the site is carried out during environmental data collection for use of renewable and alternate source of energy such as wind energy and solar energy. However, based on techno-economic considerations, the following are suggested:

a) Use of solar heaters and solar lights at public buildings such as guest houses, canteens, hospital etc

b) Use of solar lights for street lighting limited to 20%. The street lighting shall be controlled by staggering of putting on-off of lights in particular sequence.

### 10.2.5 LAND ENVIRONMENT

The main solid waste generated from the airport like plastic cups, office waste and food material. Solid waste collected during operation phase will be disposed in disposal facility owned by Government of Goa.

Hazardous waste management: From Airport, used oil, lubricants, electronic wastes shall be generated and the same shall be disposed through SPCB authorized reprocessor. Used batteries will be given to dealer as part of buy back arrangement.

## 10.3 HEALTH AND SAFETY

In order to provide safe working environment and safeguard occupational health and hygiene, the following measures will be undertaken:

- Exposure of workers to hazardous/toxic substances will be minimised by adopting suitable engineering controls.
- All the employees shall be trained in Health, Safety and Environment (HSE) aspects related to their job.
- Periodic compulsory health check up will be carried for all the site employees. Particular attention will be given to respiratory and hearing disorders. The yearly statistics along with observations will be reported each year to the chief executive of the plant.

## 10.4 GREENBELT DEVELOPMENT PLAN

A proper greenbelt plan for Mopa International airport is envisaged in the design phase. The greenbelt development should be met the 33% of total area as per MoEF stipulated norms. The greenbelt programme is proposed in phased manner.

**Guidelines for Plantation**

The plant species identified for greenbelt development will be planted using pitting technique The pit size will be either 45 cm x 45 cm x 45 cm or 60 cm x 60 cm x 60 cm. Bigger pit size is preferred on marginal and poor quality soils. Soil proposed to be used for filling the pit will be mixed with well decomposed farm yard manure or sewage sludge at the rate of 2.5 kg (on dry weight basis) and 3.6 kg (on dry weight basis) for 45 cm x 45 cm x 45

cm and 60 cm x 60 cm x 60 cm size pits respectively. The filling of soils will be completed at least 5 - 10 days before the actual plantation. Healthy seedlings of identified species will be planted in each pit.

**Species Selection**

Based on the regional background and soil quality, greenbelt will be developed. In greenbelt development, monocultures are not advisable due to its climatic factor and other environmental constrains. Greenbelt with varieties of species is preferred to maintain species diversity, rational utilization of nutrients and for maintaining health of the trees. Prepared in this way, the greenbelt will develop a favorable microclimate to support different micro-organisms in the soil and as a result of which soil quality will improve further.
During the course of survey, it has been observed that the soil quality of the plant site is fairly good and can support varieties of dry deciduous plant species for greenbelt development. Manure and vermin-compost may be mixed with the soil used for filling the pit for getting better result for survival of plant species. Adequate watering is to be done to maintain the growth of young seedlings. Based on the regional background, extent of pollution load, soil quality, rainfall, temperature and human interactions, a number of species have been suggested to develop greenbelt in and around the proposed airport. These species can be planted in staggering arrangements within the airport premises. Some draught resistant plant species have been identified which can be planted for greenbelt development if sufficient water is not available. The suitable species for greenbelt development programme are given in Table 10.1.

**Table 10.1 List of tree species suggested for green belt development**

| Sl. No. | Binomial name | Family | Type of planting |
|---|---|---|---|
| | *Anthocephalus cadamba* | Rubiaceae | All areas |
| 2. | *Alstonia scholaris* | Apocynaceae | All areas |
| 3. | *Bambusa arundinaceae* | Poaceae | Parking areas |
| 4. | *Bambusa vulgaris* | Poaceae | Roadside |
| 5. | *Calophyllum inophyllum* | Clusiaceae | All areas |
| 6. | *Couroupita guianensis* | Lecythidaceae | All areas |
| 7. | *Hibiscus tiliaceous* | Malvaceae | All areas |
| 8. | *Lagerstroemia reginae* | Lythraceae | All areas |
| 9. | *Bassia latifolia* | Sapotaceae | All areas |
| 10. | *Ailanthes excelsa* | Simaroubaceae | Avenue trees |
| 11. | *Mangifera indica* | Anacardiaceae | Avenue trees |
| 12. | *Manilkara hexandra* | Sapotaceae | All areas |
| 13. | *Mimusops elengi* | Sapotaceae | All areas |
| 14. | *Plumeria acuminata* | Apocynaceae | Roadside |
| 15. | *Plumeria alba* | Apocynaceae | Roadside |
| 16. | *Plumeria rubra* | Apocynaceae | Roadside |
| 17. | *Syzygium cumini* | Myrtaceae | All areas |
| 18. | *Terminalia arjuna* | Combretaceae | Avenue trees |
| 19. | *Terminalia catappa* | Combretaceae | All areas |
| 20. | *Thespesia populnea* | Malvaceae | All areas |

| Sl. No. | Binomial name | Family | Type of planting |
|---|---|---|---|
| 21. | *Ficus benghalensis* | Moraceae | Avenue trees |
| 22. | *Ficus religiosa* | Moraceae | Avenue trees |
| 23. | *Ficus racemosa* | Moraceae | Avenue trees |
| 24. | *Ficus microcarpa* | Moraceae | Avenue trees |
| 25. | *Murraya paniculata* | Rutaceae | Roadside |
| 26. | *Phyllanthus emblica* | Euphorbiaceae | All areas |
| 27. | *Tectona grandis* | Verbenaceae | Avenue trees |
| 28. | *Cassia siamea* | Caesalpiniaceae | Avenue trees |
| 29. | *Cassia fistula* | Caesalpiniaceae | All areas |

The species suggested here are commonly seen in and around the project area, fast growing and drought resistant. Seedlings / saplings of these species can be easily procured from local nurseries. The selection of plant species for the green belt development depends on various factors such as climate, elevation and soil. The plants suggested for green belt were selected based on the following desirable characteristics.

- Fast growing and providing optimum penetrability.
- Evergreen with minimal litter fall.
- Wind-firm and deep rooted.
- The species will form a dense canopy.
- Indigenous and locally available species.
- Trees with high foliage density, larger of leaf sizes and hairy on surfaces.
- Ability to withstand conditions like inundation and drought.
- Soil improving plants, such as nitrogen fixing plants, rapidly decomposable leaf litter.
- Attractive appearance with good flowering and fruit bearing.
- Bird and insect attracting plant species.
- Sustainable green cover with minimal maintenance
- Species which can trap/sequester carbon

In addition, a lawn and floral garden with the varieties of small flowering plants may be developed near the office site for aesthetic value of the entire complex.

**Plantation scheme**

Plant sapling will be planted in pits of about 3.0 to 4.0 m intervals so that the tree density is about 1500 trees per ha. The pits will be filled with a mixture of good quality soil and organic manure (cow dung, agricultural waste, kitchen waste) and insecticide. The saplings / trees will be watered using the effluent from the sewage treatment plant and treated discharges from project. Sludge from the sewage treatment plant will be used as manure. In addition kitchen waste from plant canteen can be used as manure either after composting or by directly burying the manure at the base of the plants. Since, tests have shown that availability of phosphorus, a limiting nutrient, is low, phosphoric fertilisers will also be added. The saplings will be planted just after the commencement of the monsoons to ensure maximum survival. The species selected for plantation will be locally growing varieties with fast growth rate and ability to flourish even in poor quality soils.

A total of more than 33% of total project area will be developed as green belt or green areas in project area and other areas. The greenbelt will be developed along the project boundary, depending on the availability of space. The areas, which need special attention regarding green belt development in the project area, are:

1. Parking areas
2. Entrance and exit points
3. Vacant Areas of the airport
4. Around Office Buildings, Garage, Stores etc.
5. Along Road Sides (Avenue Plantation)

**Post plantation care**

Immediately after planting the seedlings, watering will be done. The wastewater discharges from different sewage treatment plant / out falls will be used for watering the plants during non-monsoon period. Further watering will depend on the rainfall. In the dry seasons watering will be regularly done especially during February to June. Watering of younger saplings will be more frequent. Organic manure will be used (animal dung, agricultural waste, kitchen waste etc.). Younger saplings will be surrounded with tree guards. Diseased and dead plants will be uprooted and destroyed and replaced by fresh saplings. Growth / health and survival rate of saplings will be regularly monitored and remedial actions will be undertaken as required.

## 10.5 ESTIMATED COST FOR IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT PLAN

Considering all measures suggested above, cost is worked out for implementation of environmental management plan and is given in Table 10.2 and Table 10.3 . The total estimated budget for implementation of EMP is worked out as Rs. 300.0 Lakhs towards capital cost and Rs.90.0 Lakhs towards recurring cost per anum.

**Table 10.2: BUDGET OF ENVIRONMENTAL MANAGEMENT PLAN (Capital Cost)**

| Sl. No. | Activity | Site A | Time Frame* |
|---|---|---|---|
| | | (Rupees in Lakhs) | in years |
| 1 | **Air Environment** | | |
| 1.1 | Plantation Activities | 300 | 1 |
| 2 | **Noise Environment** | | |
| 2.1 | Plantation Activities | Included in 1.1 | Included in 1.1 |
| 2.2 | Audiometric tests | 1 | 1.5 |
| 3 | **Water Environment** | | |
| 3.1 | Rain water Harvesting pits | 15 | 0.5 |
| 3.2 | storage tank for treated wastewater and distribution network | 2 | 0.5 |
| 4 | **Land Environment** | | |
| 4.1 | Plantation Activities | Included in 1.1 | Included in 1.1 |
| 4.2 | Solid waste management tracking and development of manure pits | 2 | 1 |
| 5 | **Biological Environment** | | |
| 5.1 | Plantation Activities | Included in 1.1 | Included in 1.1 |
| 6 | **Corporate Social Responsibility** | | |

| | | | |
|---|---|---|---|
| 6.1 | Energy Conservation Measures | 10 | 2 |
| 6.2 | Use of Renewable Sources of Energy | 5 | 2 |
| 6.3 | Development of Carbon Manual & carbon footprint software | 15 | 2 |
| 6.4 | Infrastructure upgradation for Education & Health | 20 | 2 |
| 6.5 | Support for teaching aids and medical equipment | 10 | 2 |
| | **Budget for EMP (Capital Cost)** | 380 | |

* Time frame: time required for completion of the activity from the date of completion of Airport

**Table 10.3: BUDGET OF ENVIRONMENTAL MANAGEMENT PLAN (Recurring Cost per Anum)**

| Sl. No. | Activity | Cost (Rupees in Lakhs) |
|---|---|---|
| 1 | **Air Environment** | |
| 1.1 | Plantation Activities | 80 |
| 2 | **Noise Environment** | |
| 2.1 | Plantation Activities | Included in 1.1 |
| 2.2 | Audiometric tests | 0.5 |
| 3 | **Water Environment** | |
| 3.1 | Rain water Harvesting pits | 0.5 |
| 3.2 | storage tank for treated wastewater and distribution network | 0.2 |
| 3.3 | Training for marine environmental monitoring | 0.6 |
| 4 | **Land Environment** | |
| 4.1 | Plantation Activities | Included in 1.1 |
| 4.2 | Solid waste management tracking and development of manure pits | 1 |
| 5 | **Biological Environment** | |
| 5.1 | Plantation Activities | Included in 1.1 |
| 6 | **Corporate Social Responsibility** | |
| 6.1 | Energy Conservation Measures | 2 |
| 6.2 | Use of Renewable Sources of Energy | 1 |
| 6.3 | Development of Carbon Manual & carbon footprint software | 5 |
| | Total Amount | 25.5 |
| | Total amount for the complete project | 80 |
| 6.4 | **Awareness and Community Development Programmes (Neighbouring and Periphery Areas)** | 10 |
| | **Budget for EMP (Recurring Cost per Anum)** | 90 |

All activities shall be monitored every 6 months

# Chapter 11
# Consultanat's Disclosure

## 11.0 INTRODUCTION

Environment Division of Engineers of India Limited (EIL) was established in 1975 with the objective of providing specialised services in the field of environment protection to the different industrial sectors served by EIL. The division is assisted by a multi-disciplinary team with engineers and scientists with experience ranging from seven to thirty years or more and equipped with the latest computer software and hardware. It is capable of providing the entire range of services related to environmental pollution assessment, control and management to the following major sectors of industry in India and abroad:

- Airports
- Petroleum Refining
- Petrochemicals
- Oil and Gas Processing
- Metallurgy (Non-Ferrous only)
- Thermal Power Plants
- Infrastructure projects

EIL is also capable of providing environment related services for various other industries like textile, leather, pulp and paper etc. besides the different industries mentioned above. The Division has a unique advantage of utilising technological and engineering competence and experience, which is available to them in house from other specialised departments of EIL to provide the entire range of services related to environmental management.

The Division has been instrumental in designing and commissioning a large number of industrial water treatment plants, wastewater treatment plants, Environmental Impact Assessment (EIA) studies and solid and hazardous waste management. During the past two decades, several schemes have been implemented for handling wastewater as well as gaseous effluents, solid as well as hazardous wastes so that these meet the stringent regulations imposed by statutory authorities from time to time.

Much of the Division's rich and varied experience is derived from the experience of working with International funding agencies like the World Bank, International Financial Consortium and Asian Development Bank etc. The Division has worked for many World Bank funded jobs including the one concerning development of guidelines for carrying out environmental audits for small and medium scale industries. Many of these projects being grass root projects in nature have large socio-economic and cultural dimensions besides the associated environmental problems.

The present EIA report has been prepared by EIL, an engineering and consultancy organization in the country. EIL has been preparing regularly EIA / EMP reports for different projects. The environmental Engineering Division of EIL has carried out more than 300 numbers of Environmental Impact Assessment projects.

National Accreditation Board for Education and Training (NABET) - under the Accreditation Scheme for EIA Consultant Organizations has accredited EIL as EIA consultant for 10 EIA Sectors including Petroleum Refining industry. The list of sectors for which the accreditation has been accorded by NABET is published by NABET-QCI as Minutes of Meeting (MOM) in NABET website "www.qcin.org" and the same MOM is given in Fig 11.1.

**Fig 11.1: Minutes of Meeting showing EIL as EIA Consultant Organization accredited by NABET-QCI**

**NATIONAL ACCREDITATION BOARD FOR EDUCATION & TRAINING**

**QUALITY COUNCIL OF INDIA**

QCI Office, 7th Floor, ITPI Building, Ring Road, I.P. Estate, New Delhi

Scheme for Accreditation of EIA Consultant Organizations

**Minutes of 9th Accreditation Committee Meeting for Re-Accreditation held on Jan. 10, 2014**

**Present**

1. Prof. C. K. Varshney - Member
2. Prof. A. K. Maitra - Member
3. Dr. B. Sengupta - Member

Leave of absence was granted to Dr. Prodipto Ghosh, Dr. A. N. Jha, Sh. K. P. Nyati and Sh. Chandra Bhushan. Prof. Varshney chaired the meeting.

NABET Secretariat was represented by:

Mr. A. K. Ghose – Principal Advisor, Dr. Hari Prakash – Joint Director and Mr. Abhay Sharma

The following were discussed/ decided:

1. The minutes of 8th BA AC meeting dated Dec. 18, 2013 were considered and approved.
2. **Cases covering clarifications**
   - i. Ghosh Bose & Associates Pvt. Ltd., Kolkata
   - ii. Engineers India Limited, Gurgaon
   - iii. Kadam Environmental Consultants, Vadodra
   - iv. Anacon Laboratories, Nagpur
   - v. B S Envitech Pvt. Ltd., Hyderabad
   - vi. Ramky Enviro Engineers, Hyderabad

## 2.2 Engineers India Limited, Gurgaon (EIL)

Case of EIL was discussed earlier in RA AC meeting dated Dec. 6, 2013 and kept on hold for a) non-receipt of payments against assessment and b) pending further details on EIA related experience in SHW for Sh. P. K. Goel and Sh. Mayank Gupta. EIL has cleared the pending dues, however, experience submitted for Sh. Goel and Sh. Gupta was not found complete and further details with respect to work carried in SHW were sought to assess the actual work.

Closure action taken by EIL on NCs and Obs. raised in SA were verified.

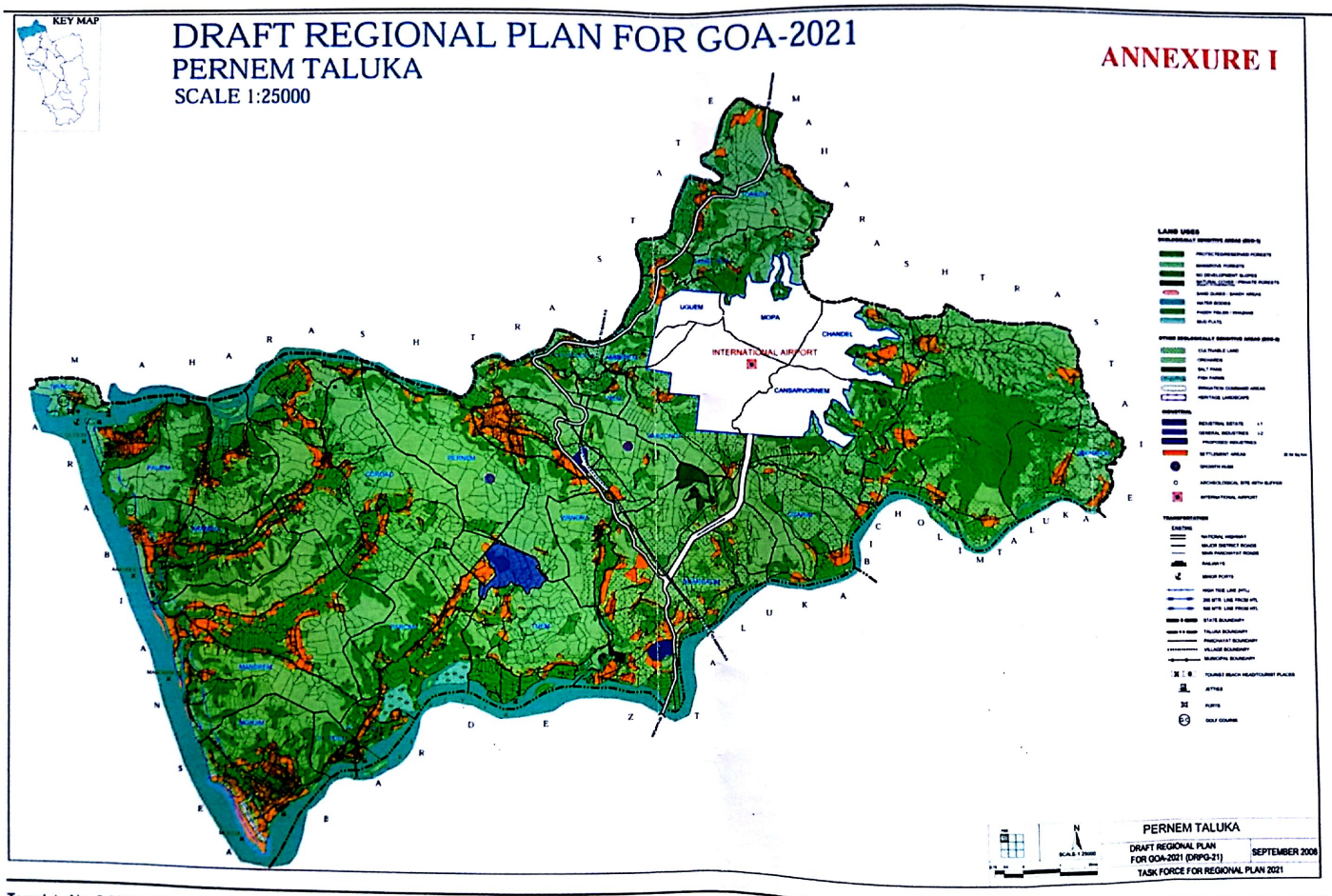
Results of the Re-accreditation (RA) assessment are given below:

The ACO has overall obtained more than 60% marks and therefore qualifies for Cat. A. However, in respect of Completeness & quality of EIAs prepared, the marks are less than 60 % indicating scope of improvement vide points mentioned below in relevant section.

### 2.2.1 Scope of Accreditation

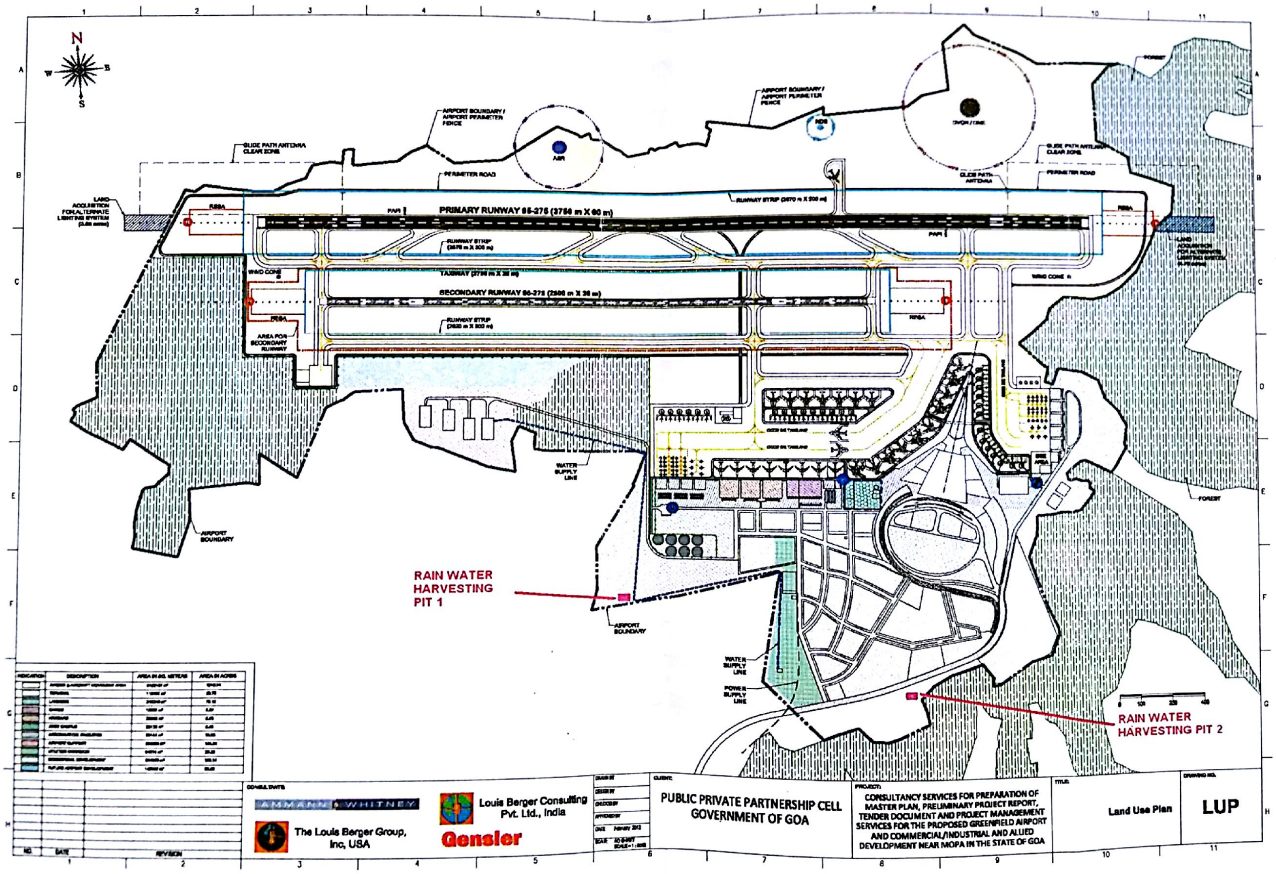
| Sl. No. | Sector No as per NABET Scheme | Name of Sector | Cat. |
|---|---|---|---|
| 1 | 1 (OC) | Mining of minerals – open cast only | On Hold |
| 2 | 4 | Thermal power plant | A |
| 3 | 8 | Metallurgical industry (Non Ferrous only) | A |
| 4 | 10 | Petroleum refining industry | A |
| 5 | 16 | Chemical fertilizers | A |
| 6 | 15 | Petrochemical complexes | A |
| 7 | 27 | Oil & Gas transportation pipelines | A |
| 8 | 29 | Airports | A |
| 9 | 32 | TSDF | B |
| 10 | 33 | Ports and Harbours | A |
| 11 | 39 | Township and Area development projects | B |

Minutes of 9th AC Meeting for Re-Accreditation: jan. 10, 2014 Page 6

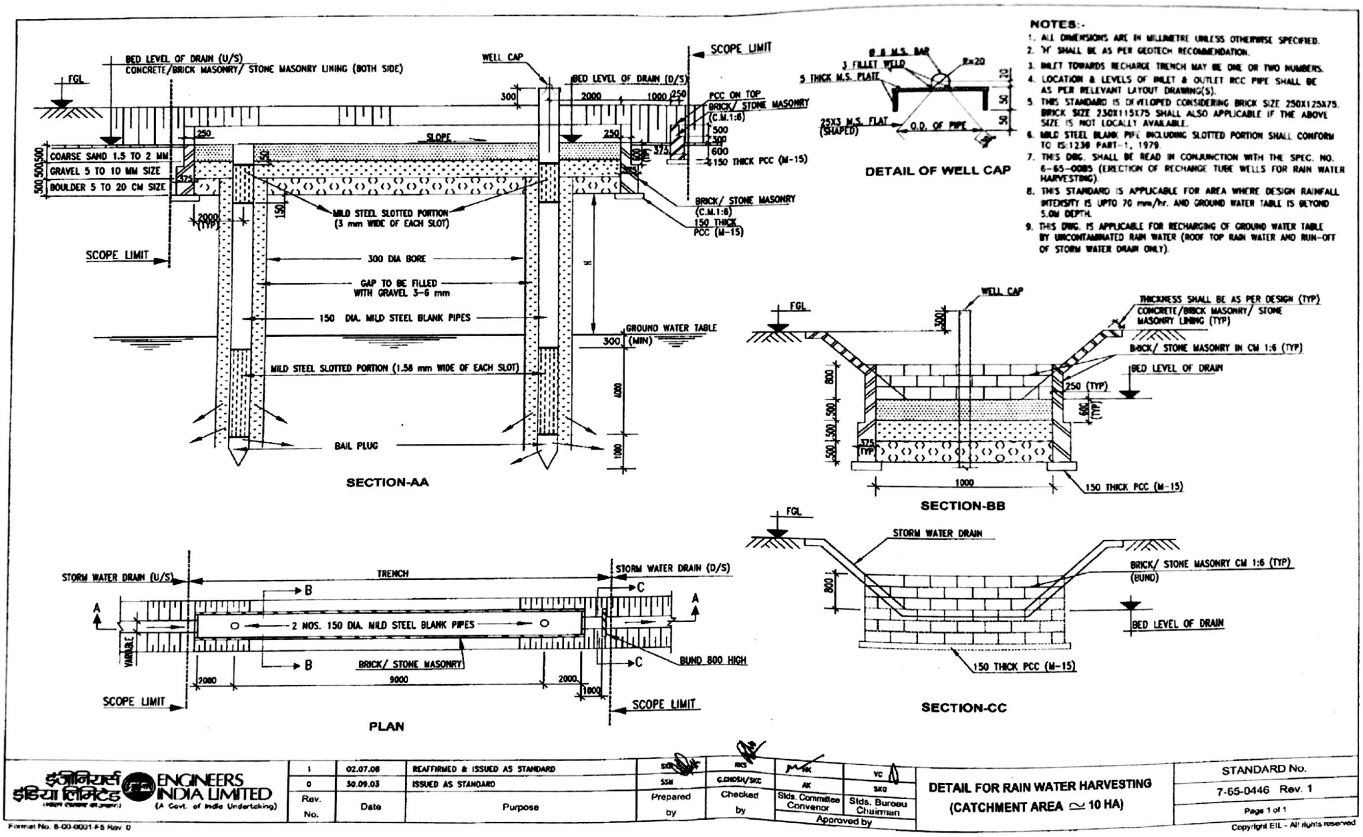


## Rainwater Harvesting Locations

**ANNEXURE II**



# ANNEXURE III




| Rev. No. | Date | Purpose | Prepared by | Checked by | Approved by |
|---|---|---|---|---|---|
| 1 | 02.07.08 | REAFFIRMED & ISSUED AS STANDARD | SSM | G.GHOSH/SKG | Stds. Committee Convenor |
| 0 | 30.09.03 | ISSUED AS STANDARD | | | |

DETAIL FOR RAIN WATER HARVESTING (CATCHMENT AREA ≃ 10 HA)

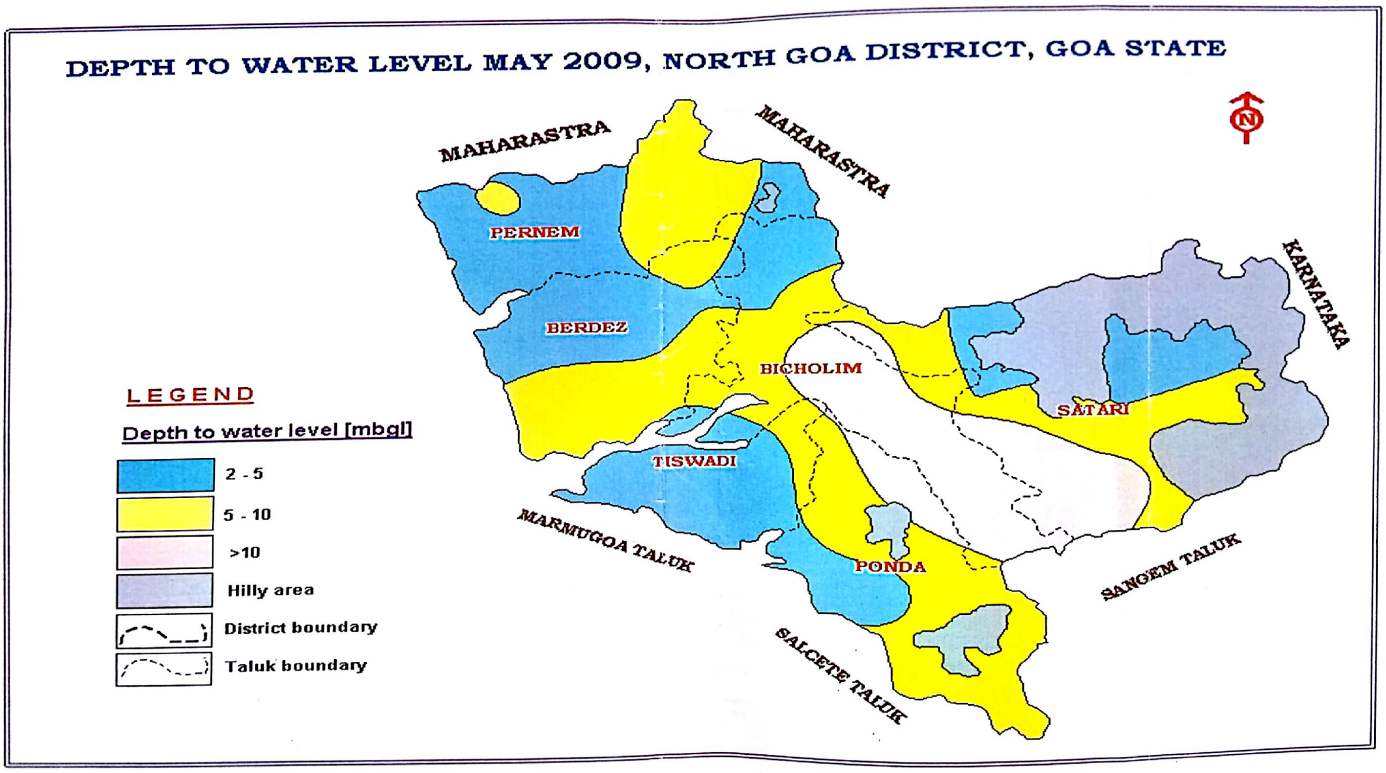
STANDARD No. 7-65-0446 Rev. 1

Page 1 of 1

Format No. 8-00-0001-F8 Rev. 0

# ANNEXURE IV

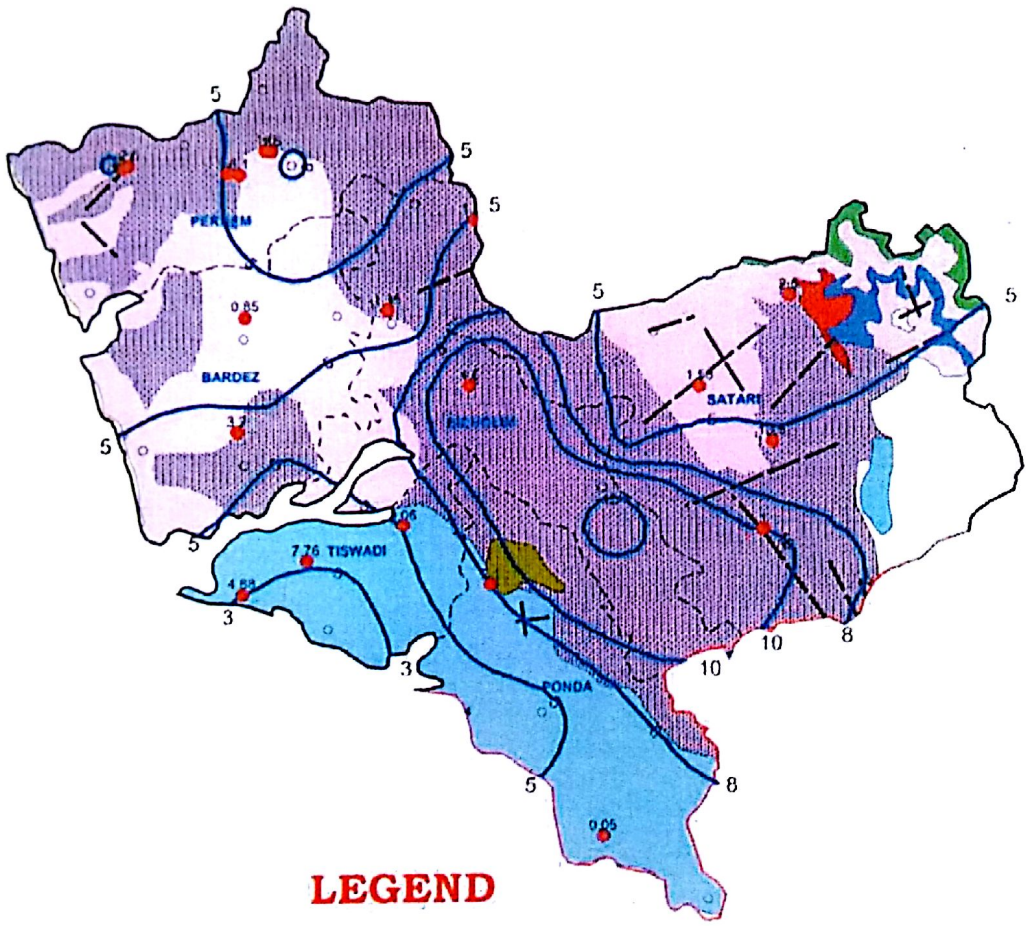
Fig-3



## ANNEXURE V

PLATE-2

# HYDROGEOLOGY
# NORTH GOA DISTRICT
# GOA STATE




## LEGEND

- Laterite
- Beach Sand
- Basalt
- Granite
- Granite gneiss
- Metabasalt
- Dolomitic limestone
- Greywacke with conglomerate
- Schist

4.06 Exploratory bore well location with discharge in lps

Ground water monitoring well location

30 Decadal mean water level in mbgl (1995-2004)

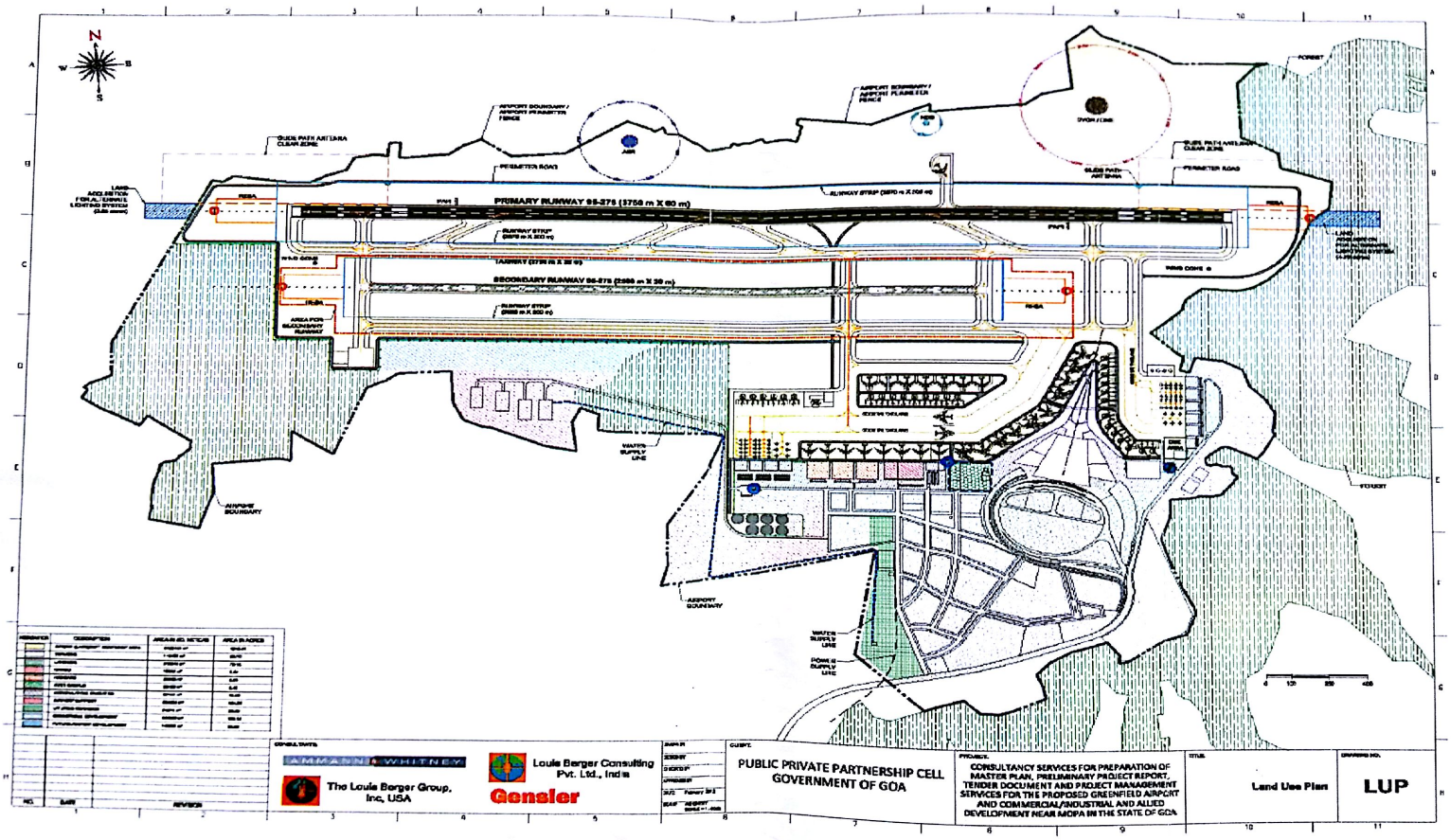
Lineament

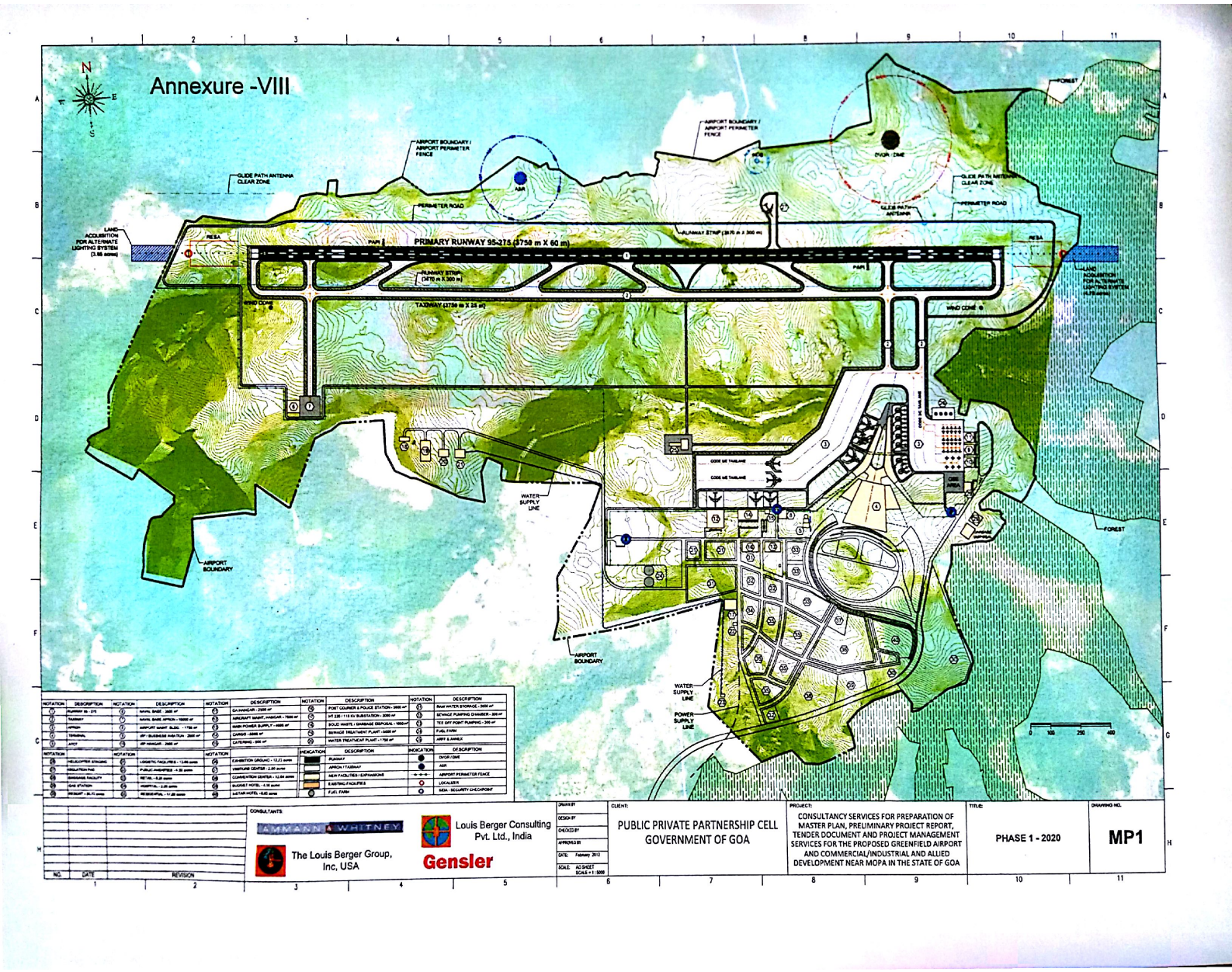
State boundary

District boundary

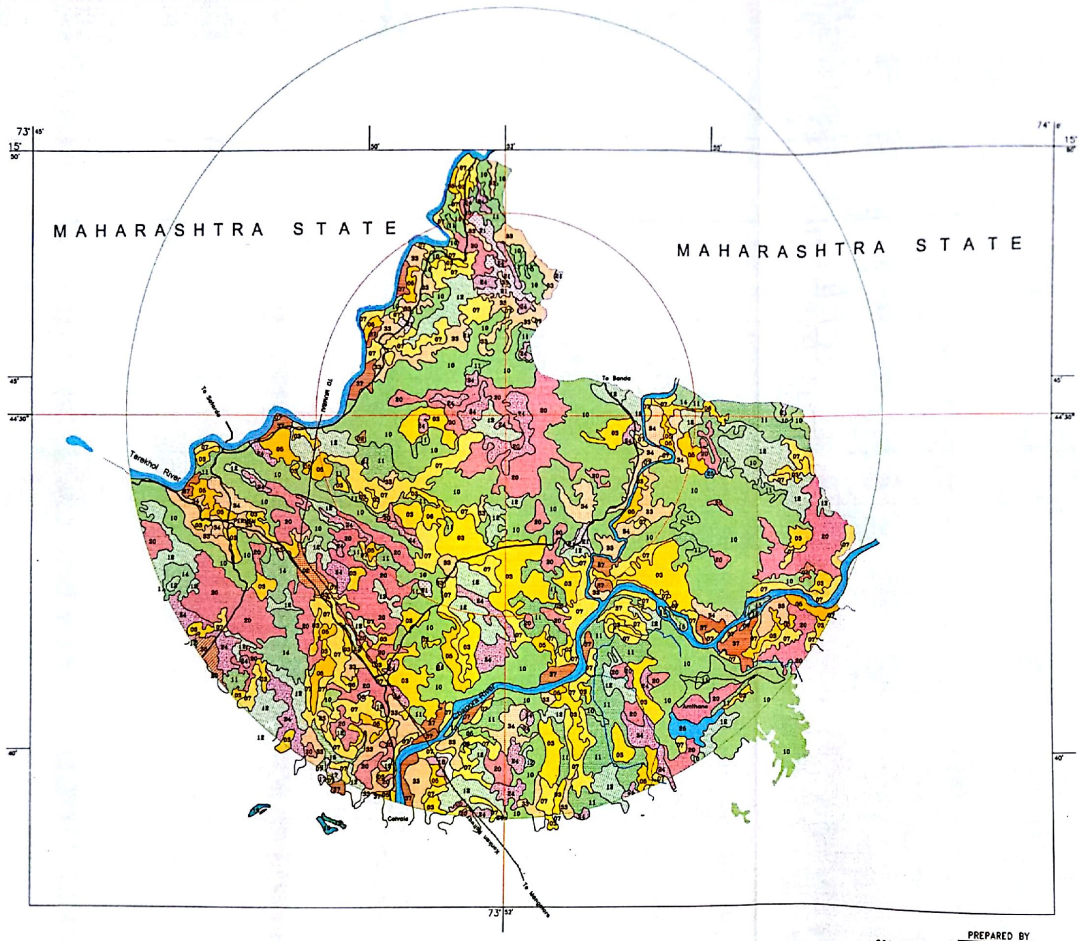
Taluk boundary

## ANNEXURE VII





ANNEXURE IX




# LAND USE/LAND COVER MAP

SCALE - 1 : 50,000

| | | |
|---|---|---|
| BUILT-UP LAND | Town /Cities | 01 |
| | Villages | 02 |
| AGRICULTURAL LAND | Crop-land | |
| | Kharif | 03 |
| | Rabi | 04 |
| | Kharif + Rabi | 05 |
| | Fallow | 06 |
| | Plantations | 07 |
| FOREST | Evergreen / Semi-evergreen | |
| | Dense | 08 |
| | Open | 09 |
| | Deciduous | |
| | Dense | 10 |
| | Open | 11 |
| | Scrub Forest | 12 |
| | Forest Blanks | 13 |
| | Forest Plantations | 14 |
| | Mangrove | 15 |
| WASTELANDS | | |
| Waterlogged Land | | 17 |
| Marshy/ Swampy Land | | 18 |
| Land with Scrub | | 20 |
| Land without Scrub | | 21 |
| Sandy area (Coastal) | | 22 |
| Barren Rocky/ Stony Waste/ Sheet Rock Area | | 24 |
| WATER BODIES | River/ Stream | |
| | Canals | |
| | Lakes/ Reservoirs/ Tanks | 25 |
| OTHERS | Gross Land/ Grazing land | |
| Dense | | 27 |
| Degraded | | 28 |
| Salt Pans | | 29 |
| Mine Pits | | 32 |
| Settlement + Orchard | | 33 |
| Settlement + Orchard + Crop | | 34 |
| Mining Area | | 35 |
| Industrial Area | | 36 |
| Khazan Land | | 37 |

| | | |
|---|---|---|
| BOUNDARY | State , Taluka | |
| ROADS | Major , Railway | |
| FOREST BOUNDARY | | |
| 5 KM BUFFER | | |
| 10 KM BUFFER | | |

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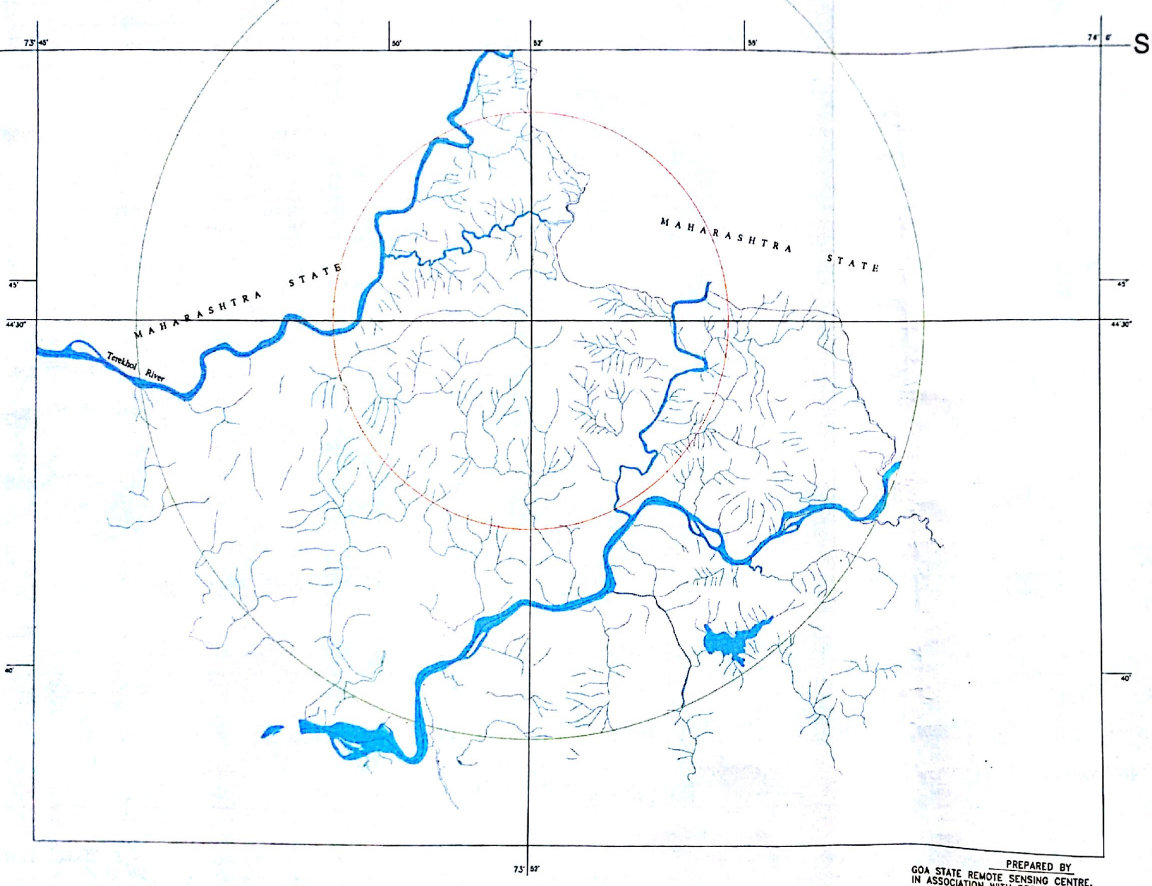
REMOTE SENSING SERVICE CENTRE,
BANGALORE & NATIONAL REMOTE
SENSING AGENCY, HYDERABAD.

ANNEXURE X




# SURFACE WATER BODY/ DRAINAGE/ WATERSHED MAP

SCALE - 1 : 50,000

TANKS (With/Without Bund)

DRAINAGE

STATE BOUNDARY

TALUKA BOUNDARY

5 KM BUFFER

10 KM BUFFER

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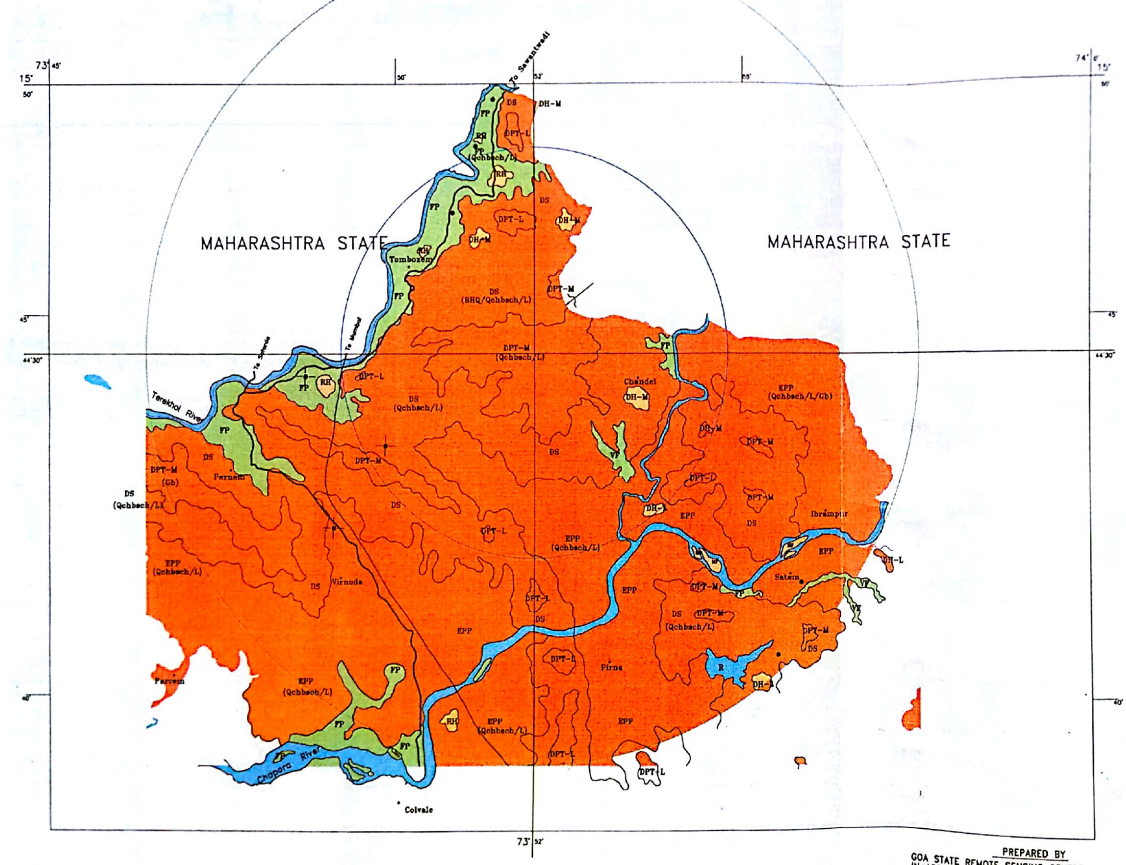
ANNEXURE XI

# HYDROGEOMORPHOLOGICAL MAP

SCALE - 1 : 50,000




| MAP SYMBOLS | GEOMORPHIC UNIT | GROUNDWATER PROSPECTS |
|---|---|---|
| FLUVIAL ORIGIN | | |
| FP | Flood Plain | Highly suitable for shallow aquifers - very good |
| MF | Mud Flat | Poor, Saline |
| DH-L | Denudational Hill - Low | Poor to Nil |
| DH-M | Denudational Hill - Medium | Poor to Nil |
| RH | Residual Hill | Poor to Nil |
| EPP | Etched Pediplain | Moderate to poor, varies with underlying lithology and structure. |
| DP-L | Denudational Slope | Poor |
| DPT-L | Dissected Plateau Top - Low | Poor |
| DPT-M | Dissected Plateau Top - Medium | Poor |

| GROUND WATER PROSPECTS | WELL DATA |
|---|---|
| Excellent to very good | Open well |
| very good to good | Dug cum Bore well |
| Good to moderate | |
| Moderate to poor | |
| Poor to Nil and Poor/Saline | |

| TOPOGRAPHY | |
|---|---|
| State Boundary | R Reservoir |
| Road | W Waterbody/Tank/Mine pit. |
| Railway | 5 KM BUFFER |
| River | 10 KM BUFFER |
| Location + Netork | |

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# Annexure VI

## DISASTER MANAGEMENT PLAN

### 1.0 Introduction

A disaster is a natural or man-made (or technological) hazard resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the environment. It is a phenomenon that can cause damage to life and property and destroy the economic, social and cultural life of people.

Natural disasters and manmade disasters like aircraft accidents, fires, terror attack & aircraft hijacking do occur at airports and therefore, it is required to prepare Disaster Management Plan (DMP). Airport emergency planning is the process of preparing an airport to cope with an emergency occurring at the airport or in its vicinity. The object of airport emergency planning is to minimize the effects of an emergency, particularly in respect of saving lives and maintaining aircraft operations. The airport emergency plan sets forth the procedures for coordinating the response of different airport agencies (or services) and those agencies in the surrounding community that could be of assistance in responding to the emergency.

The emergency arising out of the incidents whose effects are confined to the airport premises is termed as on-site emergency and those with effects extending beyond the airport premises is termed as off-site emergency. This chapter identifies possible disasters that could occur at the Greenfield Airport at Mopa and draws a disaster management plan, which includes the emergency control measures, plan of coordination and interaction with various agencies including administrative agencies, rescue and relief operations, training and awareness to minimize the severity of disasters.

### 1.1. Purpose

The purpose of a DMP is to spell out the procedures for coordinating the response of different agencies and services, both on and off the airport, to cope with various aircraft related and non-aircraft related emergencies anticipated at the airport.

### 1.2. Objective of DMP

The objectives of the emergency planning are to describe the airport's emergency response organization, the resources available and applicable response actions. Thus, the objectives of emergency response plan can be summarized as follows:

- Rapid control and containment of the hazardous situation;
- Minimizing the risk and impact of an event/accident; and
- Effective rehabilitation of the affected persons, and prevention of damage to property.

The DMP plan should be prepared in accordance with the Civil Aviation requirement laid down by the Director General of Civil Aviation (DGCA), the National Disaster Management Act, 2005, the National Building Code as well as various code provisions of the International Civil Aviation Organization (ICAO) Airport Service Manual, Part-7.

## 1.3. Types of Disasters

### 1.3.1. Natural Disasters

Natural Disasters are often sudden & intense and results in considerable destruction, injuries & death disrupting normal life as well as the process of development. Disasters due to natural calamity could be as follows

- Earthquake
- Flood
- Storm/ Cyclone
- Cloud burst/ lightning/ extreme weather conditions
- Fire

### 1.3.2. Aircraft Accident Related Disasters

Aircraft accident occurs near and within the airport during landing/take off/taxing due to malfunctioning of some mechanism like undercarriage, failure of hydraulic power supply, non-functioning of one or more engines, malfunctioning of landing gear, sudden fire in aircraft while en-routing, unforeseen circumstances in which pilot loses control over aircraft and improper signaling by air traffic control tower (ATC). Disasters due to emergencies could be as follows:

- Aircraft accident at airport
- Aircraft accident off airport
- Hazardous material emergency, hydrocarbon spills (ATF) followed by pool fire
- Fire

### 1.3.3. Terror Attack, Plane Hijack, Sabotage

The threat of bombing vital installations by enemy action or sabotage can not be ruled out near and within the airport. Since airports are vital facilities prone to terror attack/sabotage or plane hijacking, the threat to an airport could be from ground as well as from the air. Disasters due to external factors are on account of unlawful seizure, sabotage and bomb threat.

## 1.4. Categorization of Emergencies

Emergencies at airports can be classified under several broad headings. These headings are listed below together with a description of the type of emergency.

### 1.4.1. Local Standby

Local standby will be declared when an aircraft approaching the airbase is known or is suspected to have developed some defect but the trouble does not normally involve any serious difficulty in effecting a safe landing.

### 1.4.2. Aircraft Disabled/Immobilized on Runway/Taxiway

An incident such as bursting of tyres, hydraulic leakage/failure, undercarriage failure or any other technical problems, the aircraft can be disabled or immobilized on the runway or taxiway. Situation like this may require the pilot to disembark the passengers onboard in situ before the aircraft is removed or towed to its parking bay. To specifically deal with such a situation, a plan should be developed.

### 1.4.3. Full Emergency

Full Emergency will be declared when an aircraft approaching the airbase is known or is suspected to be in such trouble that there is a possibility of an accident.

### 1.4.4. Crash Action

Crash Action will be declared for aircraft accidents on the airbase as well as off the airbase. There are two types of Crash Action – for aircraft accidents that occur within the Airport Fire Service Turnout Area and for that which occur outside the Airport Fire Service Turnout Area.

### 1.4.5. In-Flight Mass Casualties

Part 1 of ICAO Annexure 6 stipulates that the pilot-in-command shall be responsible for notifying the nearest appropriate authority by the quickest available means of any accident involving his aircraft, which results in serious injury or death to any person or substantial damage to the aircraft or property. Mass casualties onboard will usually result from incidents such as an encounter with air turbulence during flight and mass food poisoning.

### 1.4.6. Fires on the Ground

Fires on the ground can be aircraft related and non-aircraft related. Fires involving aircraft can be at any location on the runway, taxiway or apron area where the aircraft is parked. Non-aircraft related fires involve mainly the airport buildings and installations.

### 1.4.7. Natural Disasters

The natural disasters to which airport are likely to be subjected to are earthquake, flood, thunder and storms. Depending on the intensity, such acts of nature may cause severe destruction to the aircraft, airport buildings and installations, and even loss of life. While nothing can be done to avert them, there are actions that can be taken at design stage to

minimize the impact and expedite restoration of airport operations during emergency using the emergency plan.

## 1.5. Disaster Management Plan

### 1.5.1. Local Standby

Local Standby is declared when an aircraft approaching the airbase is known or is suspected to have developed some defect but the trouble is not such as would normally involve any serious difficulty in effecting a safe landing.

The decision to declare Local Standby for an aircraft emergency rests with the Air Traffic Control; and the Air Traffic Control shall use the standard text and format for the declaration of Local Standby as follows:

AIRPORT LOCAL STANDBY:

- Aircraft Operator:
- Aircraft Type & Flight Number; Nature of Trouble;
- Number of Persons on Board (POB); Fuel on Board;
- Planned Runway;
- Estimated Time of Arrival (ETA); and
- Any dangerous goods on board including quantity and location, if known

### 1.5.2. Full Emergency

Full Emergency is declared when an aircraft approaching the airbase is known or is suspected to be in such trouble that there is a possibility of an accident. The decision to declare Full Emergency rests with the Air Traffic Control.

AIRPORT LOCAL STANDBY:

- Aircraft Operator:
- Aircraft Type & Flight Number; Nature of Trouble;
- Number of Persons on Board (POB); Fuel on Board;
- Planned Runway;
- Estimated Time of Arrival (ETA); and
- Any dangerous goods on board including quantity and location, if known

### 1.5.3. Aircraft Crash within Airport Fire Service Turnout Area

The Airport Fire Service turnout area shall include the entire airport area as well as the areas in the vicinity of the airport up to an arc of a circle centered at the runway threshold of 5 km radius, and 3 km from the perimeter of the airport. Crash action is declared for aircraft accidents on the airbase as well as off the airbase.

minimize the impact and expedite restoration of airport operations during emergency using the emergency plan.

## 1.5. Disaster Management Plan

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- Aircraft Operator:
- Aircraft Type & Flight Number; Nature of Trouble;
- Number of Persons on Board (POB); Fuel on Board;
- Planned Runway;
- Estimated Time of Arrival (ETA); and
- Any dangerous goods on board including quantity and location, if known

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- Aircraft Operator:
- Aircraft Type & Flight Number; Nature of Trouble;
- Number of Persons on Board (POB); Fuel on Board;
- Planned Runway;
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The Air Traffic Controller shall activate the crash alarm immediately if one of the following events occurs:

a) When the aircraft accident/ crash is sighted by the Air Traffic Controller or the sighting is reported to the Air Traffic Control by any of the reliable sources such as the "Follow-Me" vehicles plying in the aircraft movement area;

b) During poor visibility- when the Air Traffic Controller is unable to sight the runway, and the aircraft, which has been cleared for takeoff or land, fails to respond to the Air Traffic Control's repeated calls or the inputs from the Advanced Surface Movement Guidance and Control System (A-SMGCS) and other radar have indicated that the aircraft might have crashed; or

c) When the aircraft has been cleared to land and fails to land within 5 minutes of the estimated time of landing and the communication with the pilot is not able to be re-established. Or the inputs from A-SMGCS and other radar have indicated that the aircraft might have crashed.

If the crash is within the Airport Fire Service Turnout Area, the Air Traffic Control shall activate the crash alarm for at least one minute continuously, and the "Crash" message shall be broadcast over the Crash alarm communication system. The "Crash" message shall also be relayed to the Airport Fire Watch Tower.

The standard text and format used for the "Crash Action" message for aircraft crash within the airport Fire Service Turnout Area shall be as follows:

CRASH, CRASH, CRASH:

- Aircraft Type & Flight Number; Location of Accident;
- Grid Map Location [*SQUARE (Alpha-Numeric)]; Time of Accident;
- Number of Persons On Board (POB);
- Fuel On Board;
- Aircraft Operator;
- Any dangerous goods on board including quantity and location, if known

*The 'Square' is the alpha -numeric grid reference indicated on the Crash Map.

If the aircraft accident occurs on the runway, the Air Traffic Control shall give clearance for the responding airport fire vehicles to enter the runway as soon as possible.

### 1.5.4. Aircraft Crash outside Airport Fire Service Turnout Area

If an aircraft accident occurs outside the Turnout Area, the procedures for Crash Action outside the Airport Fire Service Turnout Area shall be as followed.

The decision to declare the Crash Action rests with the Air Traffic Control. If it is clear to the Air Traffic Controller that the aircraft has crash and landed outside the Airport Fire Service Turnout Area, the standard text and format used for the "Crash Action" message shall be as follows:

AIRCRAFT CRASH OUTSIDE TURNOUT AREA;

- Aircraft Type & Flight Number; Location of Accident (approximate);
- Time of Accident;
- Number of Persons On Board (POB); Fuel On Board;
- Aircraft Operator;
- Any dangerous goods on board including quantity and location, if known

State Authorities/District Administration will be overall in charge of all ground operations at the scene. All the other agencies and services involved will activate their respective emergency operations plans to support the State Authorities/District Administration in the mitigation of the aircraft accident. Local Fire Service will be fully in charge and resume command of the aircraft fire-fighting and rescue operations at the crash site.

**1.5.5. Fires on the Ground (Aircraft Related Fires Occurring in Aircraft Movement Areas)**

An aircraft can catch fire while it is taxing in the movement area or parked at an aerobridge or remote bay. Such a scenario can arise from a defect or malicious act, and may develop into a major disaster. The resources required to mitigate are thus identical to that of an aircraft crash within the Airport Fire Service Turnout Area. When the aircraft on the ground catches fire and is sighted by the Air Traffic Controller or reported to the Air Traffic Control by any reliable sources, the Air Traffic Controller shall activate the Airport Fire Service through the crash alarm communication system and provide details of the aircraft fire, for example:

- Location of aircraft;
- Nature of fire (e.g. undercarriage fire, engine fire);
- Number of Passenger On Board (POB); and
- Presence of dangerous goods, if known.

The Air Traffic Controller shall give clearance to the responding fire vehicles to enter the runway/taxiway as soon as possible. If the fire is large and has caused extensive damage to the aircraft and external resources are required to aid in the mitigation process, the Air Traffic Controller shall declare "Aircraft on Fire". The standard text and format used for the "Aircraft on Fire" message shall be as follows:

AIRCRAFT ON FIRE;

- Aircraft Operator;
- Aircraft Type & *Flight Number; Location of Aircraft;
- *Nature of Fire (e.g. undercarriage fire, engine fire);
- *Number of Persons on Board (POB);
- *Any Dangerous Goods on Board.

(*The information shall be provided if it is available and applicable.)

The Scquence of Activation for "Aircraft on Fire" shall be similar to that of "Aircraft Crash within the Airport Fire Service Turnout Area". The use of the phrase "Aircraft on Fire" is to give distinction and therefore avoid confusion between aircraft crash and aircraft on the ground on fire.

### 1.5.6. Fires on the Ground (Fires Involving Airport Buildings and Installations, i.e. Non-Aircraft Related Fires)

Fire may occur at any of the airport installations and buildings. If out of control, such a fire may cripple the key airport facilities and disrupt the normal airport operations. During a fire occurrence, however small it may appear to be, person who discovers it shall:

- Raise the fire alarm via the nearest manual call point. If no manual call point is readily available, raise the alarm by other available means;
- Inform the Airport Fire Service immediately of the exact location of the fire; and
- Operate a suitable fire extinguisher where readily available, or any water hose reel within range.

On receipt of a structural fire call, the Fire Watch Tower operator shall request the caller to provide the following details:

- Location of fire;
- Type of fire;
- Name of caller; and
- Telephone number of caller.

### 1.5.7. Dangerous Goods Accidents/Incidents

Dangerous goods accidents/incidents may occur:

- During an "Aircraft Crash" in which the aircraft concerned is carrying dangerous goods;
- During a "Full Emergency" in which the aircraft concerned is carrying dangerous goods;
- During a "Local Standby" in which the aircraft concerned is carrying dangerous goods;
- During "Fires on the Ground" in which the aircraft is carrying or in the process of loading/unloading dangerous goods; or

- When consignments of dangerous goods are damaged during loading or unloading from the aircraft or during delivery or collection from cargo terminals/warehouses within the airport.

### 1.5.8. Emergency Response for enemy action or sabotage

Bomb alert on aircraft

a) Any aircraft that is suspected of carrying a bomb should be parked in Isolated Bay Area.

b) All passengers should be evacuated immediately by the fastest means while the local or airport police arrange for bomb disposal experts to attend and search the aircraft. All baggage should be left on board until it has been searched and cleared. Airport rescue and fire services should be standby at point no less than 300m from air craft and predetermined procedure for bomb alerts should take into account the calling of local authority services of fire, police, ambulance and hospitals.

c) These types of incidents may occur on the ground or in the air including the seizure of an aircraft unlawfully, the placement of bomb on board or suspected bomb on board or armed attack on the aircraft which may include taking of hostage in such cases airport normally have contingency plan which firstly demand positioning the aircraft away from the main runway and terminal building and secondly police and law enforcement agencies are contact as necessary.

The Air traffic control must

- Maintain continuous communication with the rescue and fire fighting services to ensure that they are kept updated in relation to any change in distressed aircraft condition.
- Attend to bomb threat calls received to aircraft, terminal building, vital installations and arising from unclaimed observed insides/outside the airport and safe neutralization of explosives devices found.
- Conduct regular training of airport security police and staff, airline agencies working at the airport. This training is based for identification of explosives.

## 1.6. Role and Responsibility in Handling Emergencies

The following table summarizes the key functions for the Mopa Airport and other supporting organizations/ agencies/ services during a crisis

| S.No | Organization/ Agencies/Services | Key Function/Responsibility |
|---|---|---|
| 1 | Airport Fire Service | • Aircraft rescue and fire fighting operation<br>• Post-accident fire protection Support for triage activities<br>• Evacuate injured passengers to hospitals<br>• Support for structural fire-fighting and evacuation<br>• Support for mitigation and dangerous floods, accidents/ incidents |
| 2 | AirsideManagement/ Operation | • Activate key officials and ground handling agent concerned<br>• Muster airline's and ground handling agent's resources<br>• Provide and direct ground service supports<br>• Provide inputs to air traffic control in regard to runway and taxiway closure<br>• Coordinate aircraft recovery and salvage operation. |
| 3 | Air Terminal Management | • Activate key officials and other external agency/services such as hospitals, panel doctors, ambulance services, bureau of civil aviation security, immigration and customs<br>• Activate the Emergency Response and Interaction Centre (ERIC) Group<br>• Setup the Emergency Co-ordination Centre (ECC), Survivors Reception Centre (SRC), Friends and Relative Reception Centre (FRRC) and Re-union Area (RA)<br>• Passengers facilitation and business recovery at terminal buildings<br>• Support terminal building evacuation. |
| 4 | Engineering | • Provide technical support and assistance<br>• Support recovery efforts |
| 5 | Corporate Communication. | • Media management<br>• Facilitate press releases and<br>• Organization of press conferences |
| 6 | Air Traffic Service | • Activation and Termination of Crash Action, Full Emergency, Local standby, etc.<br>• Air traffic management including issuing NOTAM (notices to airman) |
| 7 | Police | • Guarding of aircraft wreckage and preservation of evidence at the accident site including eye-witness accounts and photography<br>• Custody of flight data and cockpit voice recorders, cargoes onboard including dangerous goods, and baggage/passenger belongings<br>• Investigation and management of dead bodies including their identity establishment, mortuary arrangements, and release of the bodies.<br>• Arrange medical examinations of the crew members alive and passengers as well as post-mortem examinations of the deceased crew members and passengers mob control. |
| 8 | Airlines | • Support overall crisis mitigation efforts e.g. accountability of passengers, management of Next of Kin (NOK), aircraft accident investigation, etc.<br>• Support media management |

| S.No | Organization/ Agencies/Services | Key Function/Responsibility |
|---|---|---|
| | | • Passenger and NOK facilitation<br>• Facilitate reunions of survivors and NOK<br>• Prepare and provide passenger and cargo manifests.<br>• Report the aircraft accident or serious incident to the authorities concerned as stipulated under Aircraft Rules, 1937, Part X Investigation of Accidents.<br>• Salvage/removal of crashed or disabled aircraft |
| 9 | Ground Handling Agent | • Provide ground service staff and facilities including passenger steps, coaches, and aircraft towing equipment. |
| 10 | Director General of Civil Aviation (DGCA) | • Set standards and directions for dealing with all aviation related emergencies<br>• Aircraft accident/ incident investigation<br>• Authorize release of cargoes onboard including dangerous goods, baggage and removal of crashed/ disabled aircraft |

## 1.7. Operation and Management Control

### 1.7.1. Airport Emergency Managing Committee

To ensure coordinated action, an Airport Emergency Managing Committee will be constituted. The airport director will be the chairman of this committee. The committee will comprise of members from various airport departments including the following

- Airport Administration
- Air Traffic Control
- Airport Rescue and Fire Fighting
- Airport Security Services
- Safety Department
- Airport Medical Services
- Maintenance Department
- Environment Management Cell
- Representative from Airlines
- Transportation Department
- Cargo Facility
- Department of Information and Publicity
- Representative from local NGO's and Social Group

Also member from Airport Authority of India and district administration will be part of the committee.

Airport emergency managing committee will design the procedure, the emergency action plan, evacuation plan and procedures for implementation based on local needs and facilities available. For effective implementation of emergency action, coordination among the

various agencies involved in Emergency Control Centre will be expected. Emergency control centre will be established as the supreme command post for emergency action. For direct action and coordination at ground level mobile command post will be established. Emergency action committee will select officers in charge for emergency control centre.

### 1.7.2. Airport Emergency Operation/ Coordination Centre

During a major airport disaster such as an aircraft crash or a severe fire outbreak at terminal building, the various emergency operations and coordination centers will be established immediately to mitigate the disaster. The Emergency Control Centre will be the top command for coordination and communication centre for all kinds of emergencies. The Chairman of Emergency Managing Committee will be the head of emergency control centre. Under his direction, chief officer will operate and regulate all emergency operation. The centre will operate under the directions of Airport Emergency Managing Committee. Its location will be fixed, as per the requirement emergency situations.

The main features of this unit will be

- Its fixed location
- It acts to guide and support to the on scene commander in the mobile command post for aircraft accidents/ incidents
- It will be operated by a specialized trained staff from Fire, Safety, Health and Environment department personnel of airport
- It will be the command, co-ordination and communication centre for unlawful seizure of aircraft and bomb threats
- It is operationally available 24 hours a day
- The location of the emergency operations centre should provide a clear view of the movement area and isolated aircraft parking position, wherever possible.

The Airport emergency operation centre should contain:

- Emergency alert and communication system.
- Adequate number of external telephones. The latest telephone directories with a list of important numbers.
- Adequate number of internal telephones and a P.A. system.
- Radio equipment, hot-lines and walkie-talkie.
- Plans of the airport to show various areas of airport
- Sources of sirens and safety equipments including fire, explosion, spill and gas controls.
- Stock of other fire extinguishing materials.

The airport emergency operations and coordination centers at the airport comprise Crisis Management Centre (CMC), Airport Emergency Response and Interaction Centre (AERIC),

Emergency Coordination Centre (ECC), Mobile Command Post (MCP), Triage Area (TA), Survivors Reception Centre (SRC), Friends and Relatives Reception Centre (FRRC) and reunion Area (RA). Each of them has its own functions and roles to perform during the crisis are as described below:

**a) Crisis Management Center (CMC)**

Established by the airport operator, the CMC is to function as an overall overseeing and controlling authority of the crisis mitigation process during an emergency. The committee of the CMC comprises the following permanent and supporting members:

Permanent members of CMC are:

- Chief Operating Officer
- Head (Engineering/Maintenance)
- Head (Utility)
- Head (Security)
- Head (Airside Management)
- Terminal Manager

Supporting members of CMC are:

- Ministry of Civil Aviation representative
- DGCA representative
- Airline concerned representative
- CISF representative
- Police representative
- Any other agencies required for proper handling of the crisis.

Functions of the CMC include:

- Formulate strategic plans and policies, as well as engage in high level decision making for the mitigation of crisis;
- Control, coordinate and support operations during an aircraft accident;
- Oversee the work and progress of protracted fire-fighting & rescue, and salvage operations;
- Liaise with the airline concerned, local authorities, ministries, and governmental departments for support;
- Arrange and provide welfare to the staff involved in the mitigation of crisis;
- Regulate the release of information to the public on the facts of the disaster;
- Authorize the release of official passenger manifest and information pertaining to the aircraft accident;

- Issue press releases and organize press conferences; and
- Ensure that the post-accident operations are completed expeditiously so that the airport can resume normal operations in the shortest possible time.

**b) Emergency Response and Interaction Centre (ERIC)**

When an accident occurs beyond the normal office hours, the CMC Committee may take longer-than-usual time to convene. As an interim arrangement, ERIC will be activated and its members will be notified as per the roster and convene within one hour of activation.

The ERIC group will carry out the general functions of the CMC until the latter comes into operation. When the CMC is operational, the ERIC will cease functioning and play the supporting roles as directed by the CMC. Before standing down the ERIC operations, the head of the ERIC group shall brief the CMC on the progress.

The ERIC Group comprises Officials on duty. The members are on a weekly rotation basis. All officials on the duty are required to have their mobile phones switched on at all times and be in a position to reach the airport within one hour of activation.

**c) Emergency Coordination Centre (ECC)**

Located near to airport gate, the ECC will be established by the airport operator, in the event of a major disaster to coordinate the response and functions of the external supporting organizations, agencies, and services involved in the mitigation of the emergency. Functions of the ECC include:

- Support crash site fire-fighting and rescue operations through liaison and coordination with the external organizations/agencies/ services;
- Facilitate mobilization of external resources to the crash site, such as issuing emergency passes and arranging with Apron Control for "Follow-me" vehicles;
- Friends and relatives facilitation at the airport; and
- Arrange and facilitate visits by the VVIPs to the crash site.

**d) Mobile Command Post (MCP)**

The MCP will be established at the accident site to serve as an on scene command, coordination and communication centre for the accident. It is a point where the co-operating agencies heads/ representatives assemble to receive and disseminate information and make decisions pertinent to the rescue operations.

The MCP will be deployed to the accident site by the Airport Fire Service and be positioned at a distance of not less than 90 m upwind from the aircraft. The MCP will be headed by

Head (Airside Operations), and Chief Airport Fire Service will be the alternate Head. When it is beyond the office hours, Duty Airport Manager (Shift-In-Charge) shall proceed to manage the MCP for the first hours until Head (Airside operations) or Chief Airport Fire Service arrives. Functions of the Mobile Command Post include:

- Establish communication with CMC and ECC.
- Establish contact with other agencies reporting at the crash site. Establish a staging area for all ground services equipment such as tow tractors, passenger steps, and coaches reporting to the crash site;
- Establish an Assembly Area for the uninjured survivors;
- Secure and provide any assistance required by the doctors at the Triage Area;
- Arrange speedy evacuation of injured casualties to the hospitals;
- Liaise with the airline concerned to transport the uninjured and casualties; and
- Maintain and update a record of casualty evacuation status including:
  - Number of casualties evacuated from the aircraft; and
  - Number of casualties evacuated to the Emergency Medical Centre, hospitals, and Survivors Reception Centre.

**e) Triage Area (TA)**

Triage area is a location established usually near to the accident site, where triage operations (i.e. sorting and classification of casualties to determine the order of priority for treatment and transportation) are performed. In an aircraft crash accident, the triage area is normally established at a distance of not less than 100 m upwind from the aircraft. In triaging, casualties are classified into four categories given below and explain in the Table below:

Priority I Immediate care
Priority II Delayed care
Priority III Minor care
Priority IV Deceased

Medical Priorities in Triage Area

| Category (priority) | Status | Arm band or Identification | Description |
|---|---|---|---|
| P-I | Immediate Case | Red | Serious injuries, hemorrhage, asphyxia, facial injuries open and compound fracture, extensive burns, crash injuries and sever shock symptoms |
| P-II | Delayed Care | Yellow | Simple fracture, limited burns, cranial trauma, rapidly progressive shock. Injuries to sort parts burns less than 30% |

| | | | |
|---|---|---|---|
| P-III | Minor Care | Green | Minor injuries-need only first aid on the spot |
| P-IV | Dead | Black | Declared dead by the doctor |

**f) Assembly Area (AA)**

The Assembly area is an area set up near the accident site to temporarily receive the survivors until the arrangements to transport them to the Survivors Reception Centre are made. Depending on the doctors' assessments of their medical condition, most priority III casualties will also join them and bring to the Survivors Reception Centre.

**g) Survivors Reception Centre (SRC)**

The Survivors Reception Centre (SRC) is a designated area set up for receiving the survivors (except for the flight crew and flight attendants) involved in an aircraft accident, for the associated documentation designed to account for the survivors and for interviews by the police officers and accident investigators. Upon receiving the "Crash" message, Terminal Manager will set up the SRC which shall be manned by the airline staff with the police taking charge of the security of the area, i.e. no unauthorized persons shall be allowed in this area. At the SRC, the airline staff shall:

- Perform head count, briefing and documentation;
- Provide care and comfort including refreshments;
- Arrange accommodations;
- Facilitate the survivors who plan to continue their journey; and
- Arrange for doctors and/or officers through ECC on need basis.

**h) Friends and Relatives Reception Centre (FRRC)**

The FRRC serves as a secure area, away from the attentions of the media, for the friends and relatives of those involved in an aircraft accident. The documentation process within the FRRC helps to confirm who was on the aircraft and facilitates the reunion. On receiving the "Crash" message, the Terminal Manager will set up the FRRC.

The airline staff shall man the FRRC, and the police shall take charge of the security of the area. At the FRRC, the airline staff shall:

- Attempt to verify the identity of the visitors on entry;
- Conduct documentation and briefing;
- Update Next to Kin (NOK) with the latest information including passenger manifest, that has been officially cleared;
- Provide care and comfort including refreshments;

- Facilitate the NOK's requests or needs;
- Break the news of fatalities to the NOK concerned in the presence of the police; and
- Arrange for doctors and/or officers through ECC on a need basis.

### 1.8. Training and Education

Regular training would be provided to all personnel who have a role in planning and operational response to an emergency. The training objectives are:

- To familiarize personnel with the contents and manner of implementation of the plan and its procedures;
- To train personnel in the performance of the specific duties assigned to them in the plan and in the applicable implementation procedures;
- To keep personnel informed of any changes in the plan and the implementing procedures;
- To maintain a high degree of preparedness at all levels of the Emergency Response Organization;
- Train new personnel who may have moved within the facility/ organization;
- Test the validity, effectiveness, timing and content of the plan; and
- Update and modify the plan on the basis of experience acquired through exercises and drills.

### 1.9. Mock Drills and Exercises

Mock drills constitute another important component of emergency preparedness and refer to the re-enactment, under the assumption of a mock scenario, of the implementation of response actions to be taken during an emergency. Mock drills and integrated exercises have the following objectives.

- To test, efficacy, timing, and content of the plan and implementing procedures;
- To ensure, that the emergency organization personnel are familiar with their duties and responsibilities by demonstration;
- Provide hands-on experience with the procedures to be implemented during emergency; and
- Maintain emergency preparedness.

The frequency of the drills would vary depending on the severity of the hazard. However, drills would be conducted once in a year. Scenarios may be developed in such a manner as to accomplish more than one event objective. Drills and exercises will be conducted as realistically as is reasonably practicable. Planning for drills and exercises would include:

- Basic objectives;
- Dates, times and places;
- Participating organizations;

- Events to be simulated;
- Approximate schedule of events;
- Arrangements for qualified observers; and
- An appropriate critique of drills/exercises with participants.

Evaluation of drills and exercises would be carried out which include comments from the participants and observers. Discrepancies noted by the drill observers during the drill shall be pointed out. The individual responsible for conducting the drill or exercise would prepare a written evaluation of the drill or exercise. The evaluation would include assessments and recommendations on:

- Areas that require immediate correction;
- Areas where additional training is needed;
- Suggested modifications to the plan or procedures; and
- Deficiencies in equipment, training, and facilities.
- Records of drills, exercises, evaluations, and corrective actions would be duly maintained.

## 1.10. Updating of Disaster Management Plan

The Disaster Management Plan and implementing procedures would be reviewed and updated to ensure compliance with relevant regulations and applicable state and local emergency plans.

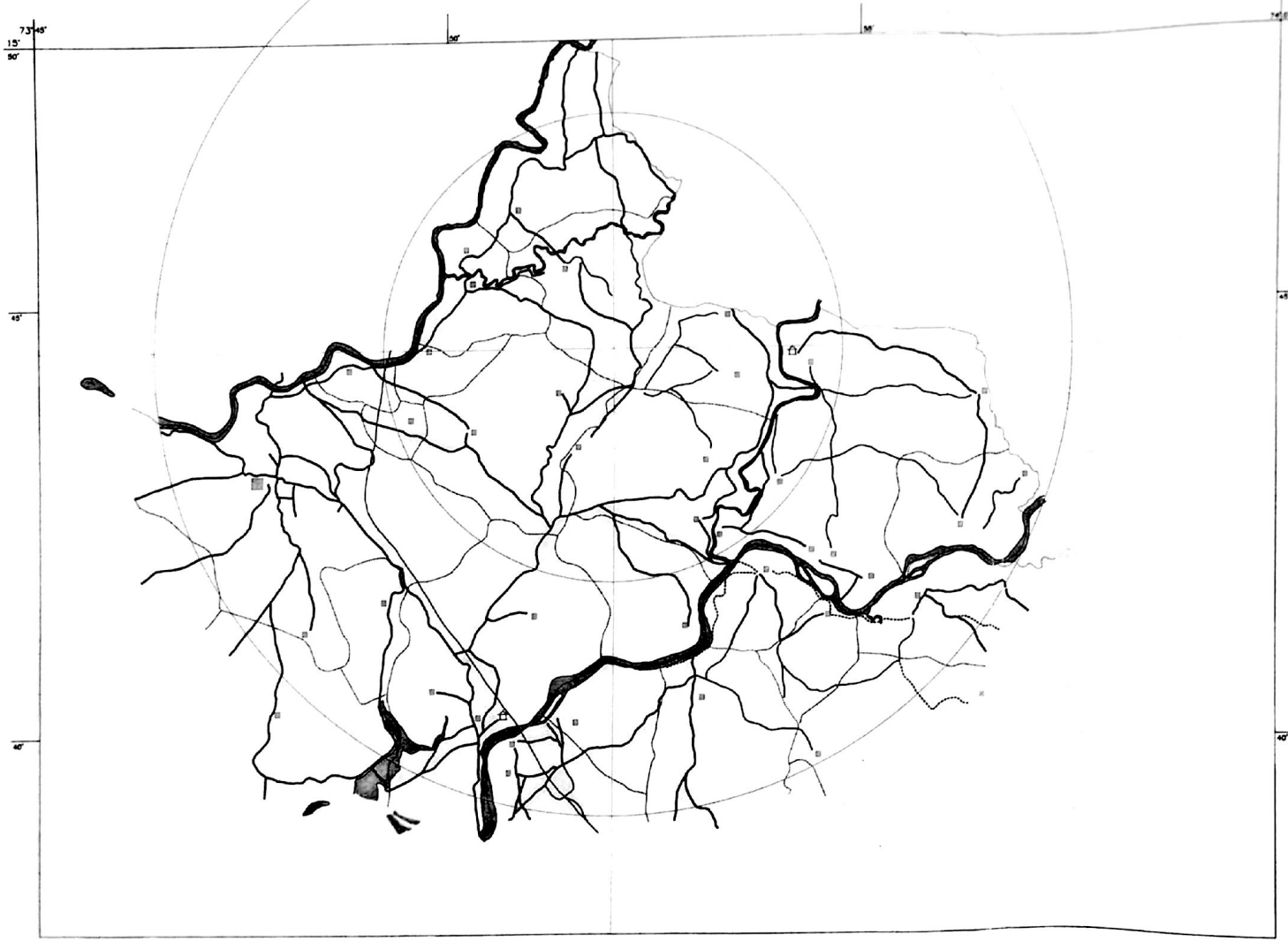
The need for updating is based on following aspects:

- Written evaluations of mock drills exercises which identify deficiencies or more desirable methods, procedures, or organizations;
- Changes in key personnel involved in the organization;
- Changes in the facility organization structure;
- Changes in regulations;
- Recommendations received from other organizations and state agencies.

ANNEXURE XII

# TRANSPORT NETWORK, SETTLEMENT LOCATION AND VILLAGE BOUNDARY MAP

SCALE - 1 : 50,000



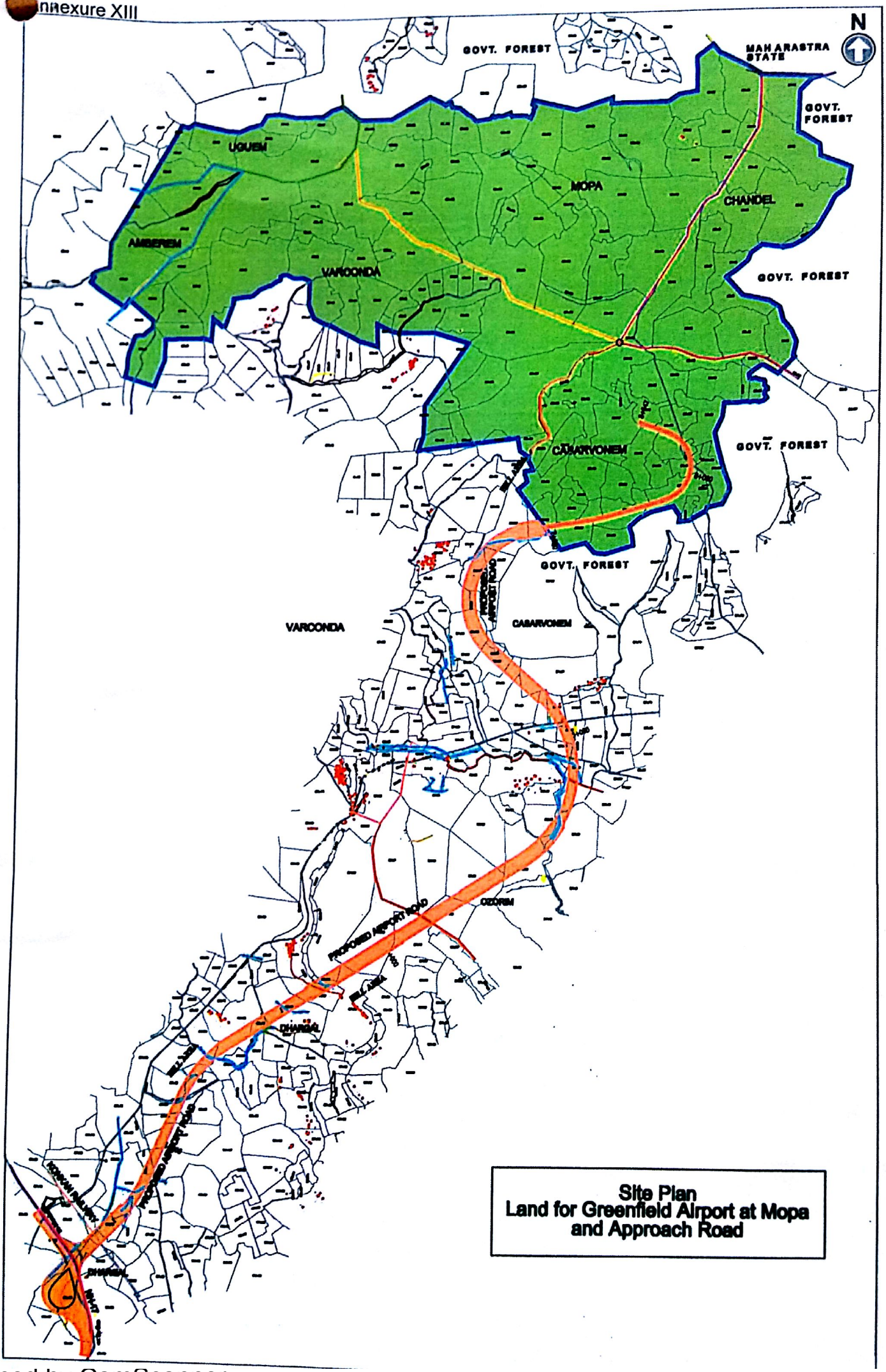
REFERENCE

- METALLED ROAD (Black top)
- METALLED ROAD (Other than Black top)
- UNMETALLED ROAD (Cart track)
- UNMETALLED ROAD (Foot path)
- RAILWAY
- SETTLEMENT LOCATION
  - Town
  - Village
- SETTLEMENT BOUNDARY
  - Village
  - Taluka
  - State
- RIVER, STREAM
- WATER BODIES Reservoir, Lake, Tank

PREPARED BY

GOA STATE REMOTE SENSING CENTRE, IN ASSOCIATION WITH REGIONAL REMOTE SENSING SERVICE CENTRE, BANGALORE & NATIONAL REMOTE SENSING AGENCY, HYDERABAD.

Annexure XIII



ANNEXURE XIV

GOVERNMENT OF GOA

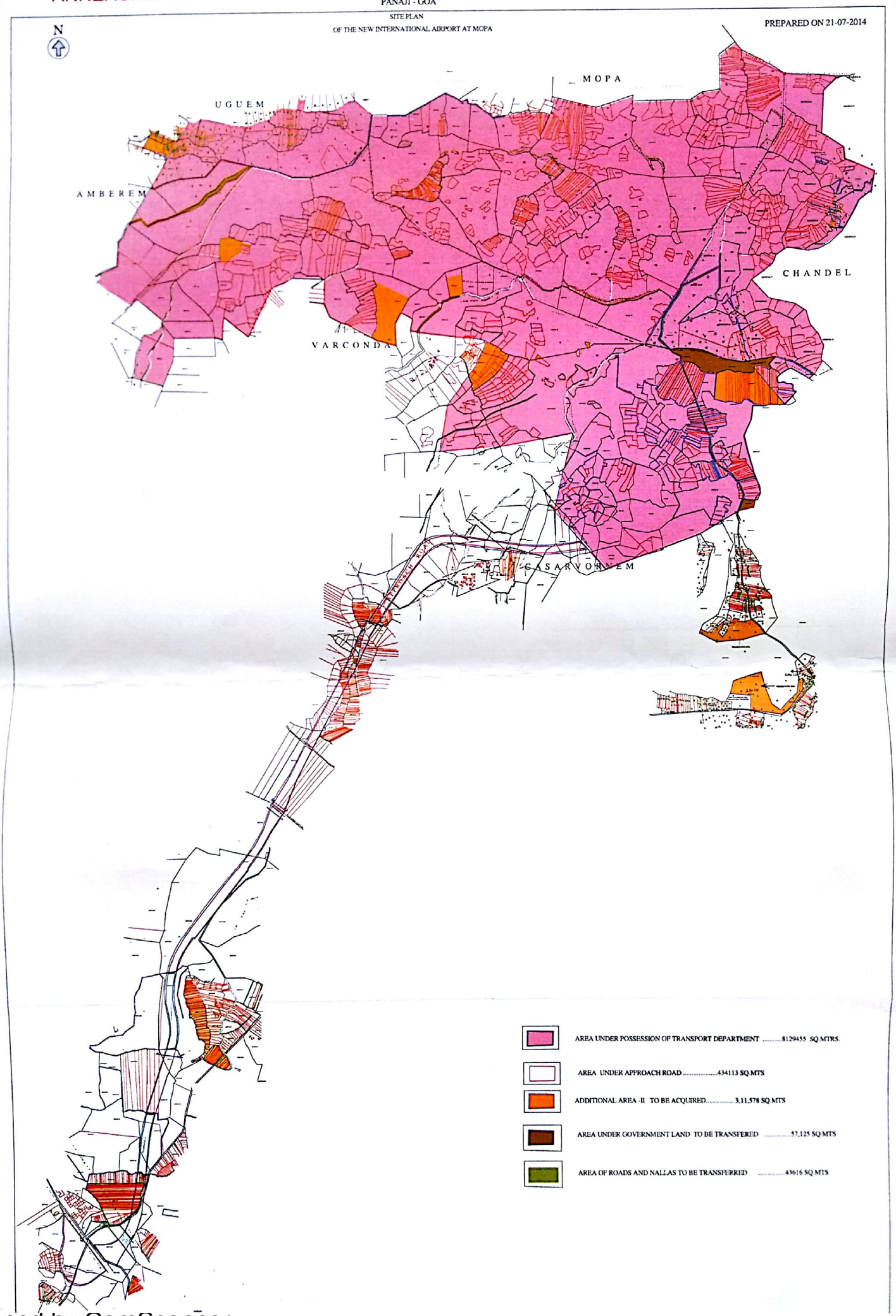
Directorate of Settlement and Land Records

PANAJI - GOA

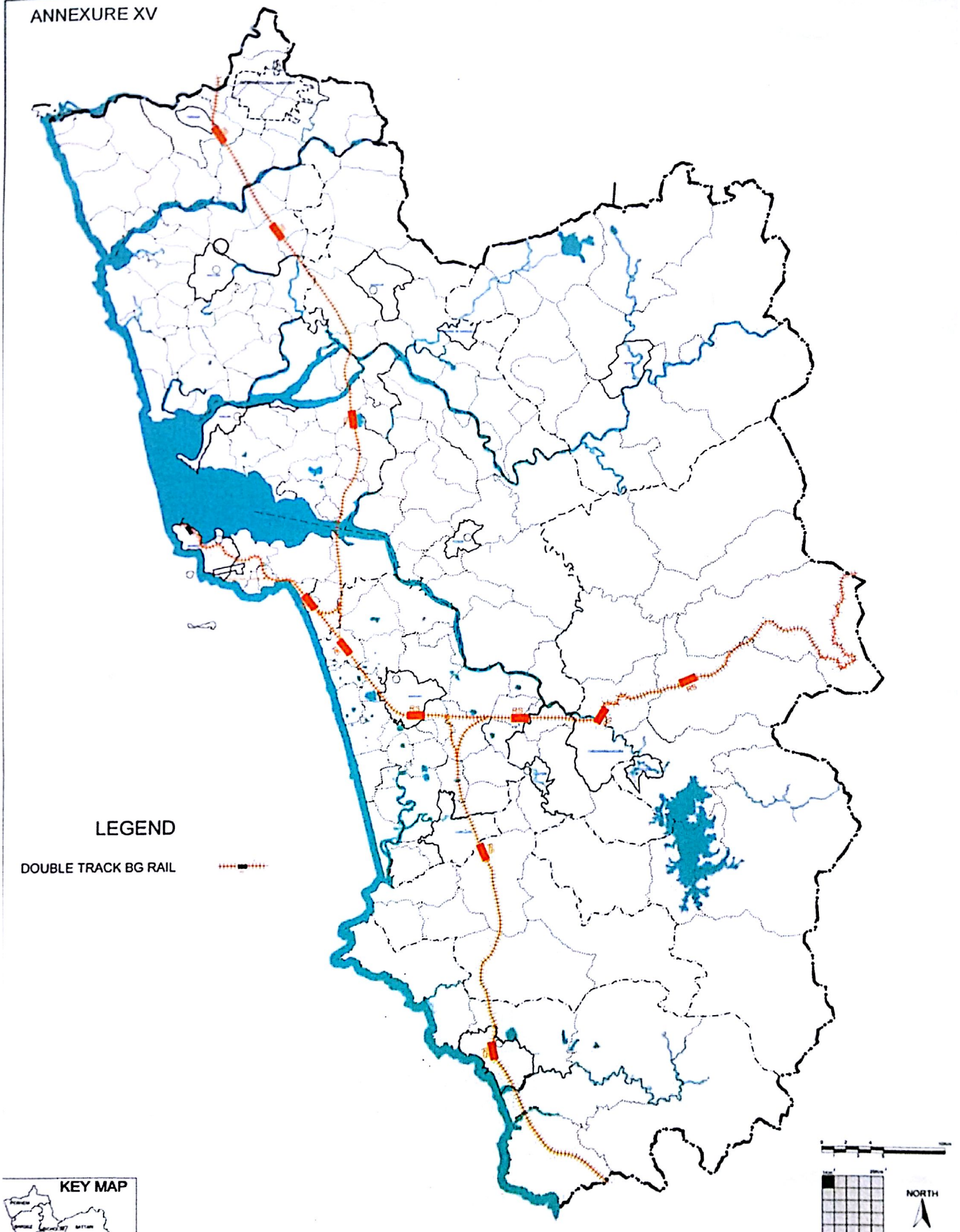
SITE PLAN

OF THE NEW INTERNATIONAL AIRPORT AT MOPA

PREPARED ON 21-07-2014



ANNEXURE XV




RAILWAY NETWORK OF GOA 2021

TASK FORCE FOR REGIONAL PLAN 2021

DRAFT REGIONAL PLAN - 2021

SEPTEMBER 2008

जहाँ है हरियाली ।
वहाँ है खुशहाली ॥

Ministry of Environment & Forests
GOVERNMENT OF INDIA, NEW DELHI

# Environmental Impact Assessment Guidance Manual for AIRPORTS

*Prepared by*

**Administrative Staff College of India**
Bellavista, Khairatabad, Hyderabad

**February 2010**

# Environmental Impact Assessment Guidance Manual for AIRPORTS

जयराम रमेश
**JAIRAM RAMESH**

सत्यमेव जयते

राज्य मंत्री (स्वतंत्र प्रभार)
पर्यावरण एवं वन
भारत सरकार
नई दिल्ली-110003
**MINISTER OF STATE (INDEPENDENT CHARGE)**
**ENVIRONMENT & FORESTS**
**GOVERNMENT OF INDIA**
**NEW DELHI - 110 003**

5TH May 2010

## FOREWORD

The EIA Notification 2006 not only reengineered the entire EC process specified under the EIA Notification 1994 but also highlighted the need to introduce specific sectors/categories under the sectors such as Industry and Infrastructure and also introduced new sectors such as Construction to be brought in the ambit of the EC process based on their extent of impacts on environment. The EIA Notification 2006 has notified 39 developmental sectors, which require prior environmental clearance. Based on the capacity, the Projects have been categorised into Category A or B which has been further categorised as B1 or B2. The Ministry of Environment and Forests (MOEF) has so far constituted 25 State level Environmental Impact Assessment Authorities (SEIAs) and State Expert Appraisal Committees (SEACs) to appraise B category projects.

The need for Sector specific manuals and guidelines for appraisal of projects under the EIA Notification 2006 has been felt for some time with a view to bringing clarity in the EC process consists of Screening, Scoping, Public Consultation and Appraisal for the purpose of granting and expediting environmental clearance. This need was further reinforced after the constitution of various SEIAs and SEACs in the various States, who were assigned this task for the first time. It was also felt that Manuals on each Sector would help in standardisation of the quality of appraisal and in reducing inconsistencies between SEACs/SEIAAs in granting ECs for similar projects in different States.

The MOEF at the first instance decided to bring out EIA Sector Specific Manuals for 37 developmental projects and the preparation of EIA Manuals of ten of these Sectors was assigned to Administrative Staff College of India (ASCI), Hyderabad.

1. Mining
2. Mineral Beneficiation
3. Ports & Harbours
4. Airports
5. (A) Building Construction
5. (B) Townships
6. Asbestors
7. Highways
8. Coal Washery
9. Aerial Ropeways
10. Nuclear Power Plants, Nuclear Fuel Processing Plants and Nuclear Waste Management Plants

The Manual for each sector contains Model TOR of that Sector, technological options and processes for a cleaner production and waste minimisation, wherever applicable, monitoring of environmental quality, related regulations, and procedure of obtaining EC if linked to other clearances for eg., CRZ, etc.

The draft Manuals were uploaded on the MOEF website and comments/responses received were considered and finalised. Since the environmental clearance process itself is a dynamic one dependent on developmental needs, technologies available and standards for cleaner environment for a sustainable development, these manuals would require regular updation in the future. I hope the Manuals in their present form are of use and we would appreciate receiving responses from various stakeholders for further improvements that could be taken up in the future.

I congratulate the entire team in the Administrative Staff College of India, Hyderabd, experts of the sectors who were involved in the preparation of the Manuals, members of the Core and Peer Committees of various sectors and various Resource persons whose inputs were indeed valuable in the preparation and finalisation of the Manuals.

(Jairam Ramesh)

*Siripurapu K. Rao*
*M.A. (Cantab), Ph.D. (Cantab)*
*DIRECTOR GENERAL*

asci
Leadership through Learning

## Acknowledgements

Environmental Impact Assessment (EIA) is a planning tool generally accepted as an integral component of sound decision-making. EIA is to give the environment its due place in the decision-making process by clearly evaluating the environmental consequences of the proposed activity before action is taken. Early identification and characterization of critical environmental impacts allow the public and the government to form a view about the environmental acceptability of a proposed developmental project and what conditions should apply to mitigate or reduce those risks and impacts.

Environmental Clearance (EC) for certain developmental projects has been made mandatory by the Ministry of Environment & Forests through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986. Keeping in view a decade of experience in the Environmental Clearance process and the demands from various stakeholders, the Ministry of Environment and Forests (MoEF) issued revised Notification on EC process in September 2006 and amended it in December 2009.It was considered necessary by MoEF to make available EIA guidance manuals for each of the development sector.

Accordingly, at the instance of the MoEF, the Administrative Staff College of India, with the assistance of experts, undertook the preparation of sector specific Terms of Reference (TOR) and specific guidance manual for airports. I wish to thank **Mr. J M Mauskar,** IAS, Additional Secretary, Govt. of India MoEF for his continuing support during the preparation of the manuals. I wish to place on record also my sincere thanks to **Dr. B Sengupta**, former Member Secretary, Central Pollution Control Board and Chairman of the Core Committee for his help in the preparation of the manuals. His suggestions helped us a great deal in improving the technical quality of the manuals. **Mr M Parabrahmam**, Former advisor MoEF and Chairman of the Peer Committee II for this project, has given constant guidance to the ASCI project team. His vast experience has been immensely helpful in preparing these manuals. I would like to thank the officials of the Ministry, **Dr. Nalini Bhat** and **Dr. T Chandini,** for coordinating the project from the Ministry side and for providing guidance whenever needed. My thanks are also due to **Dr. Bharat Bhushan** and **Dr. A Senthil Vel** of MoEF for the valuable inputs they had given during our interactions with the Officials at Delhi and Hyderabad.

I thank **Wg. Cdr. G S R Sharma**, resource person, who, drawing on his vast experience in the sector, prepared the EIA guidance manual for **airports** along with **Dr. Valli Manickam**, Member of Faculty of ASCI. The efforts put in by both of them are commendable.

I would like to thank all the Peer and Core Committee members for having given a valuable feed back in the preparation of the manual. I hope the manuals would prove to be useful to the community at large and to the experts working in this area in particular.

***26 February, 2010***

***S.K. Rao***

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# CONTENTS

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| **Shri. M. Parabrahmam**<br>Former Advisor, Ministry of Environment & Forests, New Delhi | |
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| **Member Secretary**<br>Rajasthan Pollution Control Board | |
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| **Shri. V. K. Sharma**<br>Head, Environment Division,<br>Representative of NHAI, New Delhi | |
| **Shri A. K. Debnath**<br>CG M, Central Mine Plan & Design Institute, Ranchi | |
| **Ms. Sarita Sawhny**<br>Representative of Confederation of Indian Industry, New Delhi | |

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| | |
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| **Shri G. V. Raghava Rao**<br>Former Superintending Engineer, AP Pollution Control Board | |
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| **Shri. G. Udaya Bhaskar**<br>GM-Env, Essar Group, Mumbai | |
| **Shri N. V. Bhasakara Rao**<br>AP Pollution Control Board | |
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| **Representative of GMR**<br>Samshabad International Airport Ltd | |
| **Representative of CPCB**<br>Regional Office, Bengaluru | |

# ABBREVIATIONS

ATC - Air Traffic Control
ARP - Aerodrome Reference Point
ASCI - Administrative Staff College of India
ATF - Aviation Turbine Fuel
AAQ - Ambient Air Quality
BSI - Botanical Survey of India
BLEVE - Boiling Liquid Expanding Vapour Explosion
CAEP - Committee of Aviation Environmental Protection
CPCB - Central Pollution Control Board
CRZ - Coastal Regulation Zone
CSR - Corporate Social Responsibility
EAC - Expert Appraisal Committee
EIA - Environmental Impact Assessment
EC - Environmental Clearance
ETP - Effluent Treatment Plant
EMP - Environmental Management Plan
FEDTI - Fire-Explosion and Toxicity Index
DMP - Disaster Management Plan
IA - Impact Asssessment
ICAO - International Civil Aviation Organization
IMD - Indian Meteorological Department
UTPCC - Union Teritory Pollution Control Centre
MoEF - Ministry of Environment and Forests
MCAA - Maximum Credible Accident Analysis
POL - Petrol / Paint Oil Lubricant
PCU - Passenger Car Units
RHP - Rain water Harvesting Plant
R&R - Rehabilitation and Resettlement
SPCBs - State Pollution Control Boards
STP - Sewage Treatment Plant
TOR - Terms of Reference
VOC - Volatile Organic compounds
VCE - Vapour Cloud Explosion
WG - Working Groups
WII - Wildlife Institute of India
ZSI - Zoological Survey of India

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# ABOUT THE MANUAL

Environmental Impact Notification S.O.1533 (E), dt.14th September 2006,as amended 2009, issued under Environment (Protection) Act 1986, has made it mandatory to obtain environmental clearance for scheduled development projects. The notification has classified projects under two categories 'A' & 'B'. Category A projects (including expansion and modernization of existing projects) require clearance from Ministry of Environment and Forest (MoEF), Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority (SEIAA), constituted by Government of India.

The existing manual on Environmental Impact Assessment (EIA) of MoEF, is common for all the sectors requiring prior environmental clearance. Considering the diversity in all sectors related to infrastructure and industrial development projects, MoEF launched a program for development of sector specific technical EIA guidance manuals. The EIA guidance manual will help the project proponent/consultant in the preparation of the EIA report. It also helps the regulatory authority to review the report as well as the public to become aware of the related environmental issues. This EIA guidance manual accordingly addresses the related environmental concerns for the specific sector - "Airports". This manual consists of terms of reference (TOR), manual and questionnaire.

The sector specific manual consists of twelve chapters, which correspond to the generic structure given as per EIA notification 2006, as amended Dec 2009.

### *Chapter 1: Introduction*

This chapter contains the general information on the airport sector, major sources of environmental impact in respect of airport projects and details of the environmental clearance process.

### *Chapter 2: Project Description*

This chapter contains the description of the project, such as the type of project, need for the project, project location, project layout, cargo handling methods, utilities and services, the project implementation schedule, estimated cost of development etc

### *Chapter 3: Analysis of Alternatives (Technology and Site)*

This chapter gives details of various alternatives both in respect of location of site and technologies to be deployed, in case the initial scoping exercise considers such a need.

### *Chapter 4: Description of Environment*

This chapter should cover baseline data in the project area and study area.

### *Chapter 5: Impact Analysis and Mitigation Measures*

This chapter describes the anticipated impact on the environment and mitigation measures. The method of assessment of impact including studies carried out, modelling techniques adopted to assess the impact where pertinent should be elaborated in this chapter. It should give the details of the impact on the baseline parameters, both during the construction and operational phases and suggests the mitigation measures to be implemented by the proponent.

### *Chapter 6: Environmental Monitoring Program*

This chapter should cover the planned environmental monitoring program. It should also include the technical aspects of monitoring the effectiveness of mitigation measures.

### *Chapter 7: Additional Studies*

This chapter should cover the details of the additional studies required in addition to those specified in the ToR and which are necessary to cater to more specific issues applicable to the particular project.

### *Chapter 8: Project Benefits*

This chapter should cover the benefits accruing to the locality, neighbourhood, region and nation as a whole. It should bring out details of benefits by way of improvements in the physical infrastructure, social infrastructure, employment potential and other tangible benefits.

### *Chapter 9: Environmental Cost Benefit Analysis*

This chapter should cover on Environmental Cost Benefit Analysis of the project.

### *Chapter 10: Environmental Management Plan*

This chapter should comprehensively present the Environmental Management Plan (EMP), which includes the administrative and technical setup, summary matrix of EMP, the cost involved to implement the EMP, both during the construction and operational phase and provisions made towards the same in the cost estimates of project construction and operation. This chapter should also describe the proposed post-monitoring scheme as well as inter-organizational arrangements for effective implementation of the mitigation measures.

### *Chapter 11: Summary and Conclusions*

This chapter gives the summary of the full EIA report condensed to ten A-4 size pages at the maximum. It should provide the overall justification for implementation of the project and should explain how the adverse effects have been mitigated.

### *Chapter 12: Disclosure of Consultants*

This chapter should include the names of the consultants engaged with their brief resume and nature of consultancy rendered.

The contents of the manual are to be considered as version 1.0 (2010). The ministry as per the requirements will take up an updating/revision of the manual. In case of interpretation of any question related to law, the provisions of the original laws and the Rules made thereunder with various Government directions/resolutions will have to be read and followed. In case of amendment to the original Act/Rules/Notifications made thereunder, the provisions as amended from time to time shall be applicable. Any obligations of international conventions, where GoI is a signatory and accepted for implementation are also to be followed.

# 1

# INTRODUCTION

## 1.0 Preamble

Environment plays a vital role in overall development of the country. Recognizing the importance of environmental protection and sustainable development, the Ministry of Environment and Forest, Government of India had formulated policies and procedures governing the industrial and other developmental activities to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concern in developmental projects.

Environmental Impact Assessment is a planning tool now generally accepted as an integral component of sound decision-making. The purpose of EIA is to give the environment its due place in the decision-making process by clearly evaluating the environmental consequences of the proposed activity before action is taken. Early identification and characterization of critical environmental impact allows the public and the government to form a view about the environmental acceptability of a proposed developmental project and what conditions should apply to mitigate or reduce those risks and impact.

The Ministry of Environment & Forest has made environmental clearance (EC) for certain developmental projects mandatory through its notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986. The process of conducting public hearing has also been made mandatory for certain developmental projects through its notification issued on 10.04.1997. EIA notification 2006, as amended Dec 2009 was issued by the Ministry of Environment and Forests and is in vogue now. The categorization of the developmental projects / activities is specified in this notification.

## 1.1 General Information on Airport Sector

The aviation sector has been relatively free of major environmentally driven regulations in past, because the sector is considered a key contributor to driving the global economy and the only mode of rapid trans-national travel on offer to customers. However airport development has not kept pace with significant increases in aviation activity in India. While funding is one problem; rapid pace of change in aviation technologies is the other. While joint ventures in airport development have solved the first problem, innovative planning approaches are needed to solve the second. Central actions in connection with proposed airport development often require pursuant to the implementing guidelines of the Ministry of Environment and Forests (MoEF) under Government of India (GOI), which is in the process of formulating EIA manual for airport sector according to EIA notification dated 14th September 2006, as amended 2009

Major sources of the adverse effects on account of development of airport projects are due to the following:

(a) Location of airport;
(b) Construction activities;

(c) Airport operation, including air traffic and associated noise & emissions, and
(d) Cargo handling & storage, and land transport

## 1.2 Environmental Clearance Process

In terms of the 14th September 2006, as amended Dec 2009 notification of the MoEF, all airport projects are categorized under Category A in the Schedule, including expansion and modernization of existing projects or activities, shall require prior environmental clearance from the Central Government in the Ministry of Environment and Forests (MoEF) on the recommendations of an Expert Appraisal Committee (EAC) to be constituted by the Central Government for the purposes of this notification;

| Project or Activity | Category with Threshold Limit | |
|---|---|---|
| **Airports** | **Category - A**<br>**All Projects** | **Category - B**<br>**-** |
| General Condition shall apply<br><br>"Any project or activity specified in Category 'B' will be treated as Category 'A' if located in whole or in part within 10 km from the boundary of: i. Protected areas notified under the Wildlife (Protection) Act, 1972; (ii) Critically polluted areas as notified by the Central Pollution Control Board from time to time; (iii) Eco-sensitive areas as notified under section 3 of the Environment (Protection) Act, 1986, such as, Mahabaleswar Panchangi, Matheran, Pachmarhi, Dahanu, Doon Valley and (iv) inter-state boundaries and international boundaries<br><br>Provided that the requirement regarding distance of 10km of the inter-state boundaries can be reduced or completely done away with by an agreement between the respective states or U.Ts sharing the common boundary in the case the activity does not fall within 10 kilometers of the areas mentioned at item (i), (ii) and (iii) above | | |

The environmental clearance process for new projects will comprise of a maximum of three stages. These three stages in sequential order are:

### *Stage (1)- Scoping*

'Scoping' refers to the process by which the EAC in the case of Category 'A' projects or activities, including applications for expansion and/or modernization and/or change in product mix of existing projects or activities, determine detailed and comprehensive TOR addressing all relevant environmental concerns for the preparation of an EIA report in respect of the project or activity for which prior environmental clearance is sought. The EAC concerned should determine the ToR on the basis of information furnished in the prescribed application Form 1 including ToR proposed by the applicant, a site visit by a sub-group of EAC concerned only if considered necessary by the EAC concerned and other information that may be available with the EAC concerned.

*Stage (2) - Public consultation*

Public consultation" refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impact of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate.

After completion of the public consultation, the applicant shall address all the material environmental concerns expressed during this process, and make appropriate changes in the draft EIA and EMP. The final EIA report, so prepared, shall be submitted by the applicant to the concerned regulatory authority for appraisal. The applicant may alternatively submit a supplementary report to draft EIA and EMP addressing all the concerns expressed during the public consultation.

*Stage (3) - Appraisal*

Detailed scrutiny by the EAC of the application and other document like the Final EIA report, outcome of the public consultations including public hearing proceedings, submitted by the applicant to the regulatory authority concerned for grant of EC

Flow-chart depicting these stages in obtaining the prior environmental clearance for Airport projects is presented in **Figure 1.1**

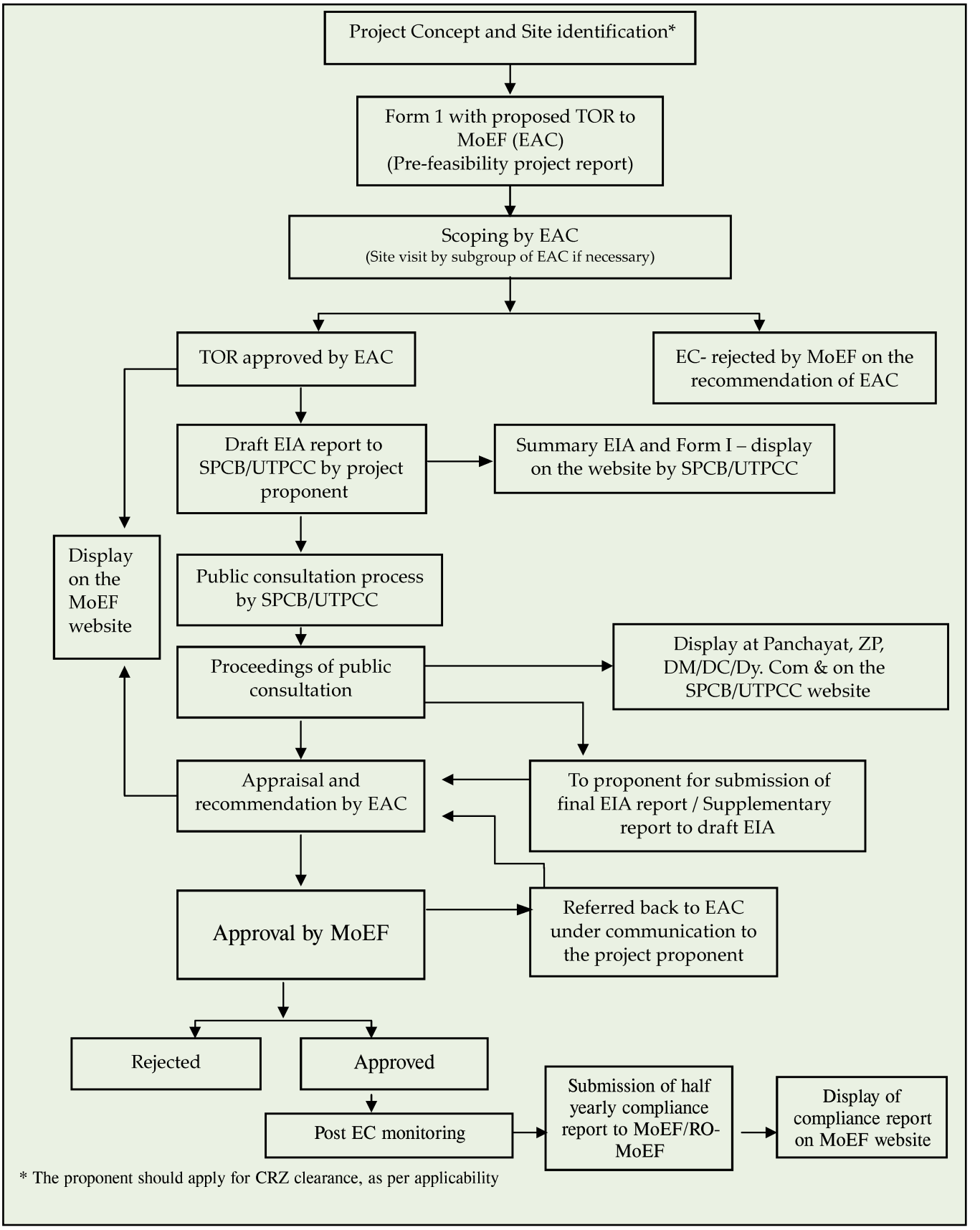



**Figure 1.1: Prior Environmental clearance process for category A projects**

- The projects involving clearance under Coastal Regulation Zone Notification, 1991 shall submit with the application a CRZ map duly demarcated by one of the authorized agencies, showing the project activities, w.r.t. C.R.Z (at the stage of TOR) and the recommendations of the State Coastal Zone Management Authority (at the stage of EC). Simultaneous action shall also be take to obtain the requisite clearance under the provisions of the CRZ notification, 1991 for the activities to be located in the CRZ
- The projects to be located within 10km of the National parks, Sanctuaries, Biosphere reserves, Migratory corridors of wild animals, the project proponent shall submit the map duly authenticated by Chief Wildlife Warden showing these features vis-à-vis the project location and the recommendations or comments of the Chief Wildlife Warden thereon (at the stage of EC)
- All correspondence with the Ministry of Environment & Forests including submission "of application for TOR/Environmental Clearance, subsequent clarifications, as may be required from time to time, participation in the EAC meeting on behalf of the project proponent shall be made by the authorized signatory only. The authorized signatory should also submit a document in support of his claim of being an authorized signatory for the specific project"

  *(Reference: S.O 3067 (E) dated 1st December 2009)*

## 1.3 Regulatory Compliance Requirement

The operational and geographic impact associated with airport development are covered by policy drives (both strategies and legislation) at global, regional and national levels.

The International Civil Aviation Organisation (ICAO), which oversees the level and direction of effort involved in addressing the environmental impact of the sector, also deals with the emissions from aircrafts.

ICAO: The ICAO agenda is focussed on the Committee of Aviation Environmental Protection (CAEP), whose 18 member states make recommendations through five groups:

- WG1-reducing noise (noise stringency limits engines);(www.icao.int)
- WG2 - land use planning and management, operating restrictions and other issues associated with noise such as modelling; (www.caa.co.uk)
- WG3-reducing emissions at source (emission limits); (www.caa.co.uk)
- WG4 - operational mechanism for reducing aviation emissions; (www.icao.int/icao/en/m.html) and
- WG5-market based options (legal & administrative issues surrounding emissions permit trading, environmental charges and voluntary agreements as a means to limit or reduce emissions) (www.icao.int).

The work of the CAEP is more technical in nature. The process of securing consensus in ICAO is lengthy, not least because membership is voluntary. Though the members are responsible for enacting certain standards and practices, they are not legally bound to do so. They are only honour bound to implement the resolution on environmental policies and practices.

India being one of the member states of ICAO, implements the resolution on environmental policies and practices adopted by ICAO through Director General of Civil Aviation (DGCA), under Ministry of Civil Aviation, GOI at national level to mitigate the operational impact associated with aviation at airports.

It ensures that environmental concerns are strategically integrated into air transport policy by improving technical environmental standards on noise and gaseous emissions; advancing long-term technology improvements; inspecting aerodrome site for issuing aeronautical clearance; improving the air traffic management and promoting flight safety environment at airports.

### Geographic Impact:

Unlike the operational impact, the geographic impact operate on a local scale over a relatively shorter period of time and are more significant. Their intensity depends on the airport capacity as well as on the site location for a given aviation environment. There is hence a requirement for legislation on the airport development sector at national level. However, this is insufficient to meet the site-specific requirements at local level. Hence, appropriate local regulation /Acts are to be incorporated to make the environmental policy sector and site specific.

Since the applicability of some of the acts, Rules to the project is site specific, project proponent has to under take a reconnaissance of the site proposed for the project, survey the demand for the sector, ensure the applicability of legislation / Acts / Rules before selecting the site and then go ahead with EC process. The Air traffic demand survey is based on the traffic projections derived from "econometric multiple correlation on forecasting methodology. In this method, past usage is correlated with variables such as income and prices and then future usage is ordinate on the basis of past relationships. This does not separate cause from effect, but uses observed historical, statistical relationships with judgemental factors applied.

Air traffic projections based on capacity driven and demand driven constraints are factored. Unaccounted traffic diverted through rail, domestic aircraft etc., due to non-availability of landing rights to foreign aircrafts is shown as potential passengers. The projections based on existing traffic, are worked out and shown in Tables 1.1 to 1.4.

Litigations if any: In some of the states, there may be some litigation in process between public / State Govt. agencies/ other industries and the project proponent or other projects relevant to the project proposed. In such cases, court rulings / directions on the matter may be mentioned. These may be studied and highlighted in the project report.

## 1.4 Terms of Reference (TOR) for Preparation of EIA Report for Airport Projects

Duly catering to the commonly expected environmental concerns, Terms of Reference (ToR) for the airports sector is prepared and given in Annexure-1. In addition, the proponent is required to identify specific issues if any, pertinent to the project and include those issues also in the ToR for preparation of EIA and EMP report upon approval of the ToR by the Expert Appraisal Committee.

## 1.5 Validity of Environmental Clearance

The prior environmental clearance granted for airports sector is valid for a period of five years. The regulatory authority concerned may extend this validity period by a maximum period of five years.

## 1.6 Post Environmental Clearance Monitoring

For category A projects, it shall be mandatory for the project proponent to make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the district or state where the project is located and in addition, this shall also be displayed in the project proponent's website permanently.

The Project management should submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions on 1st June and 1st December of each calendar year to the regulatory authority concerned. All such reports should be public documents.

## 1.7 Transferability of Environmental Clearance

A prior environmental clearance granted for a specific project or activity to an applicant may be transferred during its validity to another legal person entitled to undertake the project or activity on application by the transferor or the transferee with a written "no objection" by the transferor, to, and by the regulatory authority concerned, on the same terms and conditions under which the prior environmental clearance was initially granted, and for the same validity period.

## 1.8 Generic Structure of Environmental Impact Assessment Document

In terms of the EIA notification of the MoEF dated 14th September 2006 as amended Dec 2009, the generic structure of the EIA document should be as under:

- Introduction
- Project Description
- Analysis of Alternatives( Technology and site)
- Description of the Environment
- Anticipated Environmental Impact & Mitigation Measures
- Environmental Monitoring Programme
- Additional Studies
- Project Benefits
- Environmental Cost Benefit Analysis
- Environmental Management Plan
- Summary & Conclusion
- Disclosure of Consultants Engaged

## 1.9 Identification of Project Proponent

Profile of the project proponent, contact address with e-mail, fax, phone number etc should be furnished. All correspondence with MoEF shall be made by the authorized signatory only. The authorized signatory should also submit a document in support of his claim of being an authorized signatory for the specific project

## 1.10 Brief Description of Project Proponent

In this section details of the project nature, size, location and its importance to the country and the region are to be included. Project site description; survey/khasra nos, village, tehsil, district, state & extent of the land, latitude & longitude of the boundaries are to be furnished.

Description of existing national and international environmental laws/regulations on the proposed activity is to be brought out clearly. If there are any notified restrictions/limitations from environmental angle, issued by the district administration, State or Central government, the same should be furnished. Details of litigation(s) pending against the project/ proposed site and or any direction passed by the court of law against the project, if any, should be stated.

In case of expansion/ modernization of the project, the environmental compliance status for the existing project should be furnished for the following:

- Status of Environmental Clearance and compliance for the terms & conditions for the existing project
- Validity of the Air & Water Consent orders, and Hazardous Waste Authorization (HWA) from SPCB/ PCC for existing project
- Notices/directions issued by the regulatory agencies under section 33(A) of the Water Act, 1974 as amended, under section 31(A) of the Air Act 1981 as amended and any directions issued under the provisions of the E (P) Act, 1986 during the last one year.

# 2

# PROJECT DESCRIPTION

## 2.0 General

This chapter on project description in the EIA study report to be prepared by the proponent should include the following aspects:

- Purpose of the project, goals and objectives of the proposed project
- Overall suitability of the site and the proposed activity in light of the existing environmental acts and serious deviations, if any.
- Significance of the project both at local and national level including background information and overall scenario of the proposed activity in the Indian context
- Relevance of the project in light of the existing development plans of the region, project coverage, master plan, phasing and scope,
- Estimated cost of development of the project, environmental protection works both during construction and operations phase of the project, etc.
- Estimated water budget for the proposed project.

It is to be noted that the location as well as layout of airport structures also contribute to potential impact on the environment. The description of the project to be given in this chapter of the EIA study report should be reasonably adequate to understand the likely overall impact of the project construction and operational phases on various facets of environment. The proponent is to present the project description in the EIA report as required to obtain prior environmental clearance.

## 2.1 Description of the project

Description of the project should be brief but elaborate enough to assess the impact of the project location on the environment. Therefore these brief details should include:

- The location of the project with longitude, latitude, revenue village, tehsil, district and state
- Number of phases for development of Airport based on traffic demand,
- Capacity to handle new generation large aircraft,
- Sponsors' details,
- Envisaged project cost,
- Basis of project; BOO or BOT etc.,
- Project execution (Private or Joint Venture) (with details under Company Act 1956),
- Existing traffic; Domestic, International and Potential,
- Airport paved facilities; whether catering for futuristic operation / or existing operation.
- Villages, settlements, need for rehabilitation and resettlement (R&R) of communities/villages along with present status of such activities
- Land acquisition requirement- (present and future) and status,

*Essential Toposheets / Maps to be provided*

- A map of the study area (project area and area 10 km around its boundary) delineating the major topographical features such as land use, drainage, a location of habitats is to be given. Major constructions including roads, railways, pipelines, major industries if any in the area are to be marked clearly.
- A map of the study area covering aerial distance of 15 km from the proposed project boundary delineating environmental sensitive areas as specified in Form I of EIA notification 2006 as amended 2009 is to be shown.
- Land use map of the study area to 1: 25,000 scale, based on recent satellite imagery of the study area delineating the cropping pattern, waste land, forest area and built up area need to be prepared.
- Contour map at sufficient or acceptable intervals as available or as required for the study of project area and site plan of the area showing the proposed break-up of the land may be prepared.
- Layout plan of proposed airport development should be submitted to a scale of 1:5000. Description of covered and open facilities, landscape and other civil works such as under ground / over head water tanks; Sewage Treatment Plant(STP); Effluent Treatment Plant (ETP); Petrol / Paint, Oil, Lubricants(POL)stores; Aviation Turbine Fuel(ATF) store; Cargo storage and other maps and utilities (water & power) are to be shown in the layout (Table 2.1). Based on the terrain slope and drainage pattern of the region; perimeter boundary wall is to be planned for security of the site without allowing the storm waters to stagnate or enter project area. Key features are to be given as indicated in Table-2.2.
- Description of the project site its geology, hydrology, topography, and climate, connectivity by road/rail, demographic aspects, socio-cultural and economic aspects, villages, and settlements are to be identified.
- Details of environmentally sensitive places, land acquisition and rehabilitation of communities/ villages with their present status should be mentioned. The Siting criteria delineated by MoEF should be discussed. Notified restrictions and limitations from Environmental considerations etc., if any should be discussed.
- Historical and climatic data such as climatic conditions, rainfall, wind pattern, history of cyclones, storms surges, visibility etc. for the last 25 years are to be mentioned.
- In case of expansion/ modernization of the project, the environmental compliance status for the existing project should be explained. If the potential impact on environment exceed the existing project limits, fresh EIA process may be initiated before starting the project.
- Technologies involved for design, construction, equipment and operation should be brought out clearly in the document.
- Requirement of natural resources for construction along with their sources, technologies involved in the design, construction, equipment and operation should be furnished in the report by the proponent. Water requirement during the construction and operational phases should be covered along with the identified sources. Water balance flow chart should be prepared considering phases of construction and operation. Rainwater harvesting provisions should be explored. Utilization of solar energy for lighting etc may be explored. The resources requirement for the construction may be quantified.

Utilization of alternative construction materials such as fly ash and alternate energy such as solar etc should be explored



## 2.2 Description of Activities and Ancillary Operations

Details of various activities involved both during construction phase and operational phase along with flow charts duly indicating required resources should be described duly supported with sufficient details in appropriate tabular forms in order to enable assessment of impact of the activities on various facets of environment.

## 2.3 Housing

Requirement of housing for the workers and employees both during construction phase as well as operation phase should be specified in detailed and should be catered to by the proponent. In the event the proponent proposes to develop township for housing the workers/employees involved in the airport operations details of various types of buildings envisaged, layout plan of township, details of utilities and services along with methods of disposal and treatment of sewage should be given. The proponent should comply with all statutory provisions and directions, as may be, imposed by concerned local bodies in this regard. Details of utilities such as water supply, power supply, along with sources and distribution network should be mentioned in the EIA report.

## 2.4 Use of Public Infrastructure

The proponent should furnish the connectivities of national road and rail network to the proposed airport location. In case existing road and rail facilities are utilized for the airport activity, the proponent should furnish details of extra capacities required to augment the existing connectivity such that the infrastructure is not subjected to congestion. The layout of such road and rail facility should be incorporated in the project layout. Approval of appropriate authorities for the proposed layout of the connectivity should be pursued by the proponent and implemented as part of the project such that the public hitherto availing these utilities are not deprived of these road and rail facilities as a consequence of the post project implementation.

## 2.5 Man Power Requirement

The proponent should indicate the requirement of various categories of manpower such as skilled, semi-skilled, unskilled workers, technicians, engineers, managers and other professionals for both construction phase and operational phase. The proposed training methods for imparting and upgradation of specialized skills, where required, should be mentioned in the EIA Report.

## 2.6 Project Implementation Schedule

The proponent should also submit the detailed project implementation schedule bar chart, CPM / PERT chart etc., duly bringing out interrelationship of major activities.

# 3

# ANALYSIS OF ALTERNATIVES (TECHNOLOGY & SITE)



## 3.0 General

If the scoping results in need for alternatives, a clear description of the each alternative, and summary of the impact - adverse and positive with each site, and selection of alternatives are to be explained in detail.

## 3.1 Alternative Evaluation Criteria

Alternative sites and design process should be critically examined to maintain the positive environmental impact, socio-economic benefits & profitability and minimise the temporary adverse impact. Normally, the extent of displacement of people, the loss of agricultural land, relocation of flora & fauna and irreversible loss of natural resources permanently, will be deciding factors in selection/rejection of site. Project planning and the design process need to be flexible enough to adopt the modified basic project alternatives. The following steps will help in this process.

*Source:* Introduce proactive measures in the project design at source level to mitigate environmental impact, (e.g. ICAO measures on Aircraft design, redesign of storage tanks for storing hazardous material, landscape design, flood control measures and flight safety measures to counter risks due to birds and wildlife at airport.).

*Process:* Introduce reactive measures in the operational procedures (e.g. ICAO measures for flight procedures, Air traffic system procedures for surface traffic, sewage treatment plants, effluent treatment plants, waste disposal procedures, and rain water harvesting etc.,)

*Receptors:* Introduce defensive measures in the relocation of receptors.(e.g. Legally mandated procedures in relocation, safety and health of population and flora and fauna, and third party risk mitigation)

*Funding:* Incorporate budgeted funding for alternatives as described.

### *Multi Nodal Transportation, Environmental Impact & Trade offs:*

Review the demand for the air transportation in the region, analyse the possibility of meeting it through alternate modes of transport such as road / rail. This involves study of interrelationships between environmental impact due to airports and the trade offs in which one impact has to be traded off against another

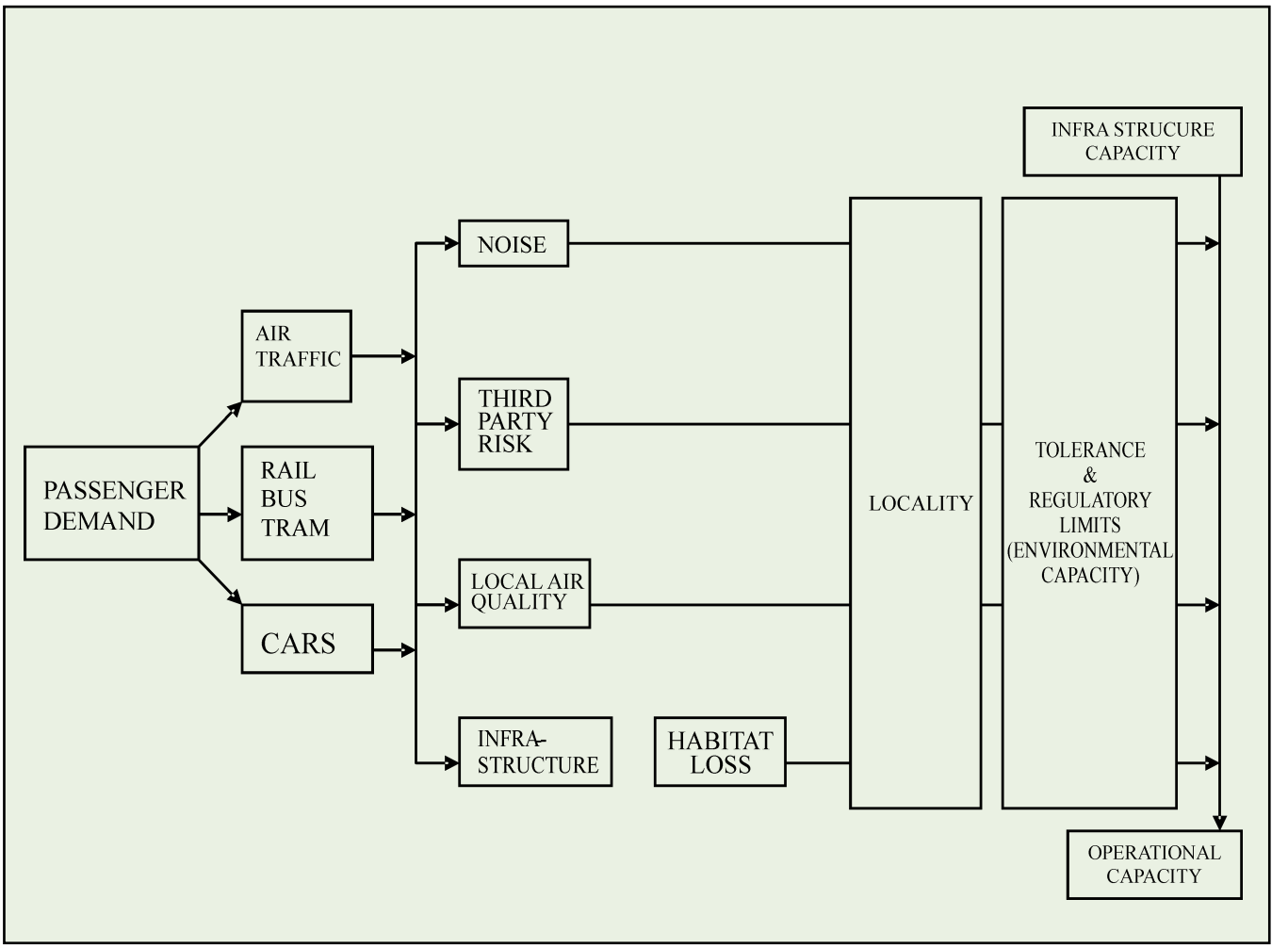



**Fig 3.1 Interrelationships in Potential Impact**

Fig3.1 provides schematic representation of the way in which different environmental impact relate to each other. It also indicates the regulatory and other social controls or restrictions that are associated with them and shows how these could reduce or restrict the operating capacity of an airport. The figure also provides a useful way of illustrating other trade offs. For example, local emissions arising from growing road traffic could in theory cause the air quality management zone in which the airport is located to fail to meet local air quality regulations. This constraint could be alleviated by the construction of a rail link to reduce car use, however, this would require additional land - take that could be restricted by habitat protection issues in the surrounding country side.

For example, the development of preferred noise routes designed to reduce community disturbance can result in departing aircraft having to fly farther during the early phase of flight. This can increase fuel burn and engine emissions. There may also be conflicts between the requirement at an airport to reduce fuel burn and emissions, and requirement to minimise noise.

# 4

# DESCRIPTION OF ENVIRONMENT

## 4.0 General

Airport development may create a wide range of impact on the environment by construction work, reclamation, landfills, noise and emissions from aircraft effecting air quality and ground sources, cargo operations, and other airport related activities. Environment facets to be considered in relation to airport development can be categorized into seven groups: (a) land use (b) water quality (c) air quality (d) noise pollution (e) biological changes (f) socio-economic changes and occupational health and (g) solid waste management. Hence it is necessary to ascertain the baseline data of these environmental facets.

## 4.1 Study Area

Primary data through measurements and field surveys; and secondary data from secondary sources are to be collected in the study area within 10 km radius from Aerodrome Reference Point (ARP). Primary data should cover one season other than monsoon and secondary data is to cover one full year. The basis for selection of these criteria is that the aircraft gains a height of 1000ft in this area below which noise and air pollution are generated maximum during its take off stage. Secondary data should be collected within 15 km aerial distance for the parameters as specifically mentioned at column 9 (III) of Form I of EIA Notification, 2006. Details of secondary data, the method of collection of secondary data, should be furnished. Similarly the proposed locations of monitoring stations of water, air, soil and noise etc should be shown on the study area map.

The study areas mentioned in this document should be considered for guidance purpose but the exact study area for different environmental attributes (water, air, noise and soil etc.) is to be submitted considering the proposed activities and location, along with proper reasoning, for review and approval by the Expert Appraisal Committee.

Baseline data of various environmental parameters envisaged to be effected by airport activities are collected from secondary sources and through primary monitoring in the study area. This baseline data helps in evaluation of the predicted impact on various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact assessment methodologies. This further helps in preparing an Environmental Management Plan (EMP) outlining the measures for improving the environmental quality and scope for future expansions for environmentally sustainable development. The baseline environmental study also helps to identify the critical environmental attributes, which are required to be monitored after implementation of the project.

The methodology involves analysis of secondary data including satellite imagery, to describe the existing environmental status in the study area of the project referring to the source of the data in each case. The primary data on the other hand describes the existing environmental status in an area of 10km radial distance from ARP through scientifically designed monitoring network. The methods defer from one parameter to the other. The basis for this depends on the relevance of the parameter and the impact of the airport activity on it.

## 4.2 Land Environment

### *Soil:*

Land is one of the important and rare resources. Airport projects require considerable land area for development of activity areas, operational and non-operational buildings, areas for ancillaries, utilities including townships. Sometimes acquisitions of large stretches of land and areas being used by the local habitat may be necessitated requiring rehabilitation measures. Availability of land for earmarking for the airport without causing undue hardship to local habitat and their socio cultural and economic aspects is very important. Studies on land use aspects of ecosystem play an important role in identifying sensitive issues in the past and present development of the region. Existing baseline status of land use can be determined through a study of changes in the land use pattern in the past 10yrs by collecting data from secondary sources such as census, and land records. Interpretation of satellite data of current year will bring out the trends in the changes of land use pattern in the past. The land use pattern in study area is analysed with the help of a map to 1:25000 scale based on recent satellite imagery of the study area delineating the cropping pattern, forest area and built-up area etc. (Annexure-2).

Soil refers to the loose material composed of weathered rock and other minerals and also partly decayed organic matter that covers large parts of the earth's surface. It is an essential component of the terrestrial eco system. It acts as a medium of transport of various dissolved materials to the underlying ground water. Hence, impact on soil is important in EIA study. Soil formation is influenced mainly by climate, geology, relief and other biotic interactions. The soil characteristics in the study area of the project, which would affect the agricultural and afforestation potential of the area need to be studied.

Soil data including type, classification, characteristics, properties, etc are important from engineering considerations for structures etc. Changes in soil parameters may also affect plantation and vegetation, which in turn may endanger the health of habitat. Baseline data consisting of soil analysis -physical and chemical (Tables 4.1 and 4.2) within the project area is to be collected to assess its fertility. Data pertaining to coverage of land for other purposes and general slope of the terrain within the study area is collected to assess the trends in the land use patterns and the natural run off patterns.

Soil samples are collected all around the project site covering the agricultural and reserved forestland, if any in the study areas. Sampling frequencies and the methods of baseline environmental quality monitoring are given in Annexure 3. The samples are collected during the study period and analysed for physical, chemical parameters and heavy metal concentrations, as per standard methods of analysis. The nature of the soil is to be discussed based on the classification.

### *Physiography and Drainage Patterns:*

The terrain and hill slope, general slope and elevation of the area, the flow direction of streams and rivers, the water bodies and wet lands and the vegetation which together describe the physiography of the land, will control the drainage pattern in the region. Land farms, terrain, may get affected due to construction of airport. It may require large scale quarrying, dredging and reclamation, which may cause changes in the topography. This in turn may affect the drainage pattern of the land / terrain. Baseline data pertaining to existing land at the proposed project area including the description of terrain hill slopes terrain features, slope and elevation are to be collected. Study of land use pattern, habitation, cropping pattern, forest cover, environmentally

sensitive places etc., is to be undertaken by employing remote sensing techniques and ground truthing. Ecological features of forest area; agricultural land; grazing land; wildlife sanctuary land & national parks; migratory routes of fauna; water bodies; and drainage pattern including the orders of the drain and water sheds are to be described. Settlements in the study area may be delineated with respect to ARP on the site map. High rise buildings, industrial areas and zones, slaughter houses and other features of flight safety importance may also be marked on the map. Secondary data from Central Water Board GOI; State ground water department, State Irrigation Department is to be obtained. Geomorphology of the region is to be clearly delineated. Study of land use patterns, habitation, cropping pattern, and forest cover data is undertaken. Information on the location of water bodies, drainage, forests, surface travel routes with respect to the project site is obtained within the study area and plotted on a map. This map will show the natural slopes and the drainage patterns, which give a guideline while planning the drains in the airport project. The drains help in discharge of storm water from the airport to avoid flooding and water logging in the project area.



## 4.3 Water Environment

Ground water quality is important, as change in its chemical parameters will affect the water quality. Airport activities during construction / operation may have impact on ground water quality. Due to airport construction existing low areas may be reclaimed with dredged spoil. The pollutants from dredged spoil are likely to enter into the ground water. This is likely to increase sedimentation of pollutants in airport area, which may migrate in time to the neighbouring ground water. Also runoff from solid waste if any, may percolate into the ground and may contaminate the ground water. Hence, they need to be studied through primary surveys and secondary sources. Monitoring locations are to be finalized as per CPCB norms which can represent the baseline conditions.

Ground water, surface water and waste water within study area are examined for physico-chemical, heavy metal and bacteriological parameters. The samples are collected and analysed as per procedures prescribed (Annexure 3). Baseline data on location sources of surface water like water bodies, lakes, their dimensions, present quality and their utility are to be provided. The location of sampling stations is to be provided as shown in Table 4.3. Similarly baseline data on the groundwater, surface water is to be provided. Water Table contour map for the pre monsoon months are made for the study area based on secondary data collected from state ground water board. Criteria for raw water used for organized community water supplies (surface and ground water) primary parameters are given in Annexure 4.

## 4.4 Air Environment:

Ambient air quality (AAQ) is important for the airport projects. The significance of aviation's impact on air quality will vary depending on many other factors such as, background pollution levels, other sources of pollution, weather and proximity of residential areas. Around many airports some large emission sources already exist (power stations, factories) that are not related to the airport at all. Also local roads and motorways, even roads associated with an airport, may be heavily used by non-airport traffic.

Aircraft engines produce emissions that are similar to other emissions resulting from any oil based fuel combustion. These, like any exhaust emissions, can affect local air quality at ground level. It is emissions from aircraft below 1,000ft, above the ground (typically around 3km from departure or, for arrivals, around 6km from touchdown) that are chiefly involved in influencing

local air quality. These emissions disperse with the wind and blend with emissions from other sources such as emissions from domestic sources , emissions from industries and from surface transport.

Important sources of emissions from airport include:

- airside and landside ground transport
- aircraft emissions from takeoff, approach and landing, engine testing and taxiing
- use of auxiliary power units to provide energy to stationary aircraft and ground power units.
- Fuel spillages, fire training, and construction activities

The local air quality relevant emissions attributed to aircraft operations at airports are oxides of nitrogen (NOx), carbon monoxide (CO), Hydrocarbons (HC), sulphur dioxide(SO2), particulate matter (PM10 and PM2.5). Aircraft engines, auxiliary power units, apron vehicles, de- icing, and apron spillages of fuel and chemicals that emit these pollutants. Local factors influence the significance of individual emissions for each airport, but often NOx is by far the most abundant and is considered the most significant pollutant from an air quality stand point. Standard emission factors, for various operation types for a range of common civil aircraft engine types maybe obtained from International Civil Aviation Organization (ICAO) database. Annexure 5.1 to 5.3.

The ambient air quality in area with radial distance 10km. from Aerodrome Reference Point (ARP), forms the baseline information. For new airport development, the sources of air pollution, for baseline studies are vehicular traffic, dust arising from unpaved village roads, domestic fuel burning and nearby industrial air emissions. For expansion / modernisation projects, additional pollutants include the airside and geographic sources in the airfield.

### Meteorological Data

The methodology adopted for collection of micro meteorological data specific to the site is to compile the Mean monthly normals of atmospheric parameters, from previous 10yrs data recorded by the nearest IMD station. The parameters selected are atmospheric pressure in (mb) and relative humidity in percentage both recorded at 0830hrs & 1730hrs IST of each day. Maximum and minimum temperatures in 0C of each day; 24hrly rainfall in millimetres (mm) recorded at 0830hrs IST and 1730hrs of each day. The normals for each month are to be calculated and shown in a tabular form. Wind Roses for each month giving the wind direction, speed and percentage frequency; as per key Index and scale should be given. Most probable wind speed class and wind direction at the nearest IMD site is to be estimated from this. Sunshine duration, cloud cover "normal values" is to be compiled from secondary data for getting the monthly "normals".

The methodology adopted for monitoring surface observations is to be as per the standard norms. Onsite monitoring will be undertaken for one season except monsoon season for recording various meteorological variables in order to generate the site - specific data (Annexure 3). This data is then compared with the meteorological data of IMD for judging its reliability and consistency with regional meteorology.

The Central Monitoring Station (CMS) equipped with continuous monitoring equipment to record wind speed, direction, temperature (2m & 10m levels) and solar radiation is to be set up at the project site. Relative humidity and atmospheric pressure are recorded manually daily at 0830hr, and 1730hrs. Data on cloud cover and storms is recorded by visual observation. Rainfall is

monitored daily by rain gauge. Hourly averages of maximum and minimum values of wind speed, direction, solar radiation and temperature are recorded continuously at the site.

Upper air climatic data is useful in locating ground and elevated inversions and computing hourly mean mixing heights ,which are required for use in air dispersion models. They can be procured from nearest IMD station and other secondary sources. The air quality monitoring stations should be given as shown in Table 4.4 and the data is to be measured and recorded as shown in Table 4.5. The standards are given in Annexure 5.4.

## 4.5 Noise Environment



The effect of noise on population depends on the characteristics of the source, the time of its existence and the location with respect to the noise sensitive land use. Noise can cause Noise Induced Hearing Loss (NIHL) to annoyance depending on its loudness. The effects of noise from proposed airport, construction activity, and vehicular traffic can cause potential damage to hearing, physiological responses, annoyance and general community responses. The ambient noise measurement frequencies and standards are given in Annexure 3 and Annexure 6 respectively. The existing noise levels before starting the construction of airport are to be measured for collecting baseline data. The process is to be repeated during construction and operational phases of project as well.

Baseline data on noise survey is collected in the project area on a given day during study period at a given location covering residential, commercial and silence zones continuously for 24hrs, at hourly intervals. During each hour parameters like L10, L50, L90 and Leq are directly computed by the instrument capable of measuring Sound pressure Level (SPL) , Leq and octave band frequency analysis. The description of noise levels measured over a given (Leqs) of time interval is given using statistical quantities. These are calculated as per the noise level exceeding over certain percentage of time during the study period.

L10 is the noise level exceeding 10 percent of time,

L50 is the noise level exceeding 50 percent of the time,

L90 is the noise level exceeding 90 percent of the time,

Leq is the hourly equivalent noise level value computed by the noise integrating sound level meter.

Lday is the equivalent sound level (average noise level during 6am to 10 pm).

Lnight is the equivalent sound level (average noise level during 10 pm to 6 am.)

Ldn is Day Night sound level (24 hr equivalent sound level with weighted penalty for night) for community noise from all sources. Here 10 dB (A) is added to instantaneous sound value during night before calculating 24hrs average.

Ldn= 10 log 1/24 {i=1to15 (sigma) 10 (leq i/10) + i=1to9 (sigma) 10 {(leq i+10)}] .

The data is to be presented as shown in Table 4.6.

## 4.6 Biological Environment

Airport operations may cause change in local ecosystems, threaten endangered species, and disturb movements and breeding patterns of local wildlife. Airports are located within a variety of settings (both urban and rural), which support habitats and species of their own, some of which will have direct interaction with those located on the airport and vice versa. Some local areas will also be

designated for their nature conservation value. The biological environment of the airport should hence be seen as an integral component of the wider landscape scale ecological network. To accomplish this,

- Baseline data from field observations for various terrestrial and aquatic systems are to be generated.
- Comparison of the data with authentic past records to understand changes is undertaken.
- Environmental components like land, water, flora and fauna are characterised and,
- The impact of airport development on vegetation structure in and around project site is to be understood.

Data on sensitive habitats, wild or endangered species in the project area also is to be collected from Zoological Survey Of India (ZSI), Botanical Survey of India (BSI), Wildlife Institute of India (WII) and Ministry of Earth Sciences. Wildlife symbolizes the functioning efficiency of the entire eco system. Just as wild flora needs special treatment for preservation and growth, wild fauna as well deserves specific conservatory pursuits for posterity. As per Wildlife Act (1972), the various wild animals are enlisted in the schedules of wildlife Act based on the intensity of threat to them as rare, endangered, threatened, vulnerable etc. Primary data on survey of the wild animals and birds in the study area is collected and identified with the classification into various schedules taken from secondary data.

In case water bodies are located in the study area plantation analysis for one season is to be undertaken (Annexure 3)

## 4.7 Socio- Economic Environment

Airport development may often require relocation of the local community, which, sometimes causes ethnic, cultural, tribal or religious conflicts with local people. Industrialization and modernization may change the cultural traditions of the local community. To study the socio-economic aspects of people in the study area around proposed airport, baseline data on demographics, land used patterns, water resources for agricultural and industrial use, human settlements, health status of the communities, infrastructure facilities and economic conditions in the existing and relocated area, cultural and archaeological assets within the project area should be catalogued and presented.

Baseline data is collected from various secondary sources, such as District Census Statistical Handbooks -1991, and records of National Informatics Centre, New Delhi and supplemented by the primary data generated through process of a limited door to door socio-economic survey during the study period and during other stages of the project. Results are to be compiled and presented as in Table 4.7 and Table 4.8.

## 4.8 Solid Waste

Solid waste generation, in airport development is in three stages namely, site preparation, construction and operation. The types of waste, which are generated, can be classified into 4 categories namely, construction or demolition waste; municipal waste, i.e., biodegradable and recyclable waste; hazardous waste and E- waste.

Details of authorized municipal solid waste disposal facilities, biomedical treatment facilities and hazardous waste disposal facilities in the area are highlighted. The adequacy of these measures vis a vis waste generated is to be assessed and alternate measures need to be initiated.

5

# ANTICIPATED ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

## 5.0 GENERAL

The aim is to ensure that potential environmental problems are foreseen and avoided at an early stage in planning cycle so as to pre-empt problems. The EIA mechanism shall be applied to the project in the following order of priority:

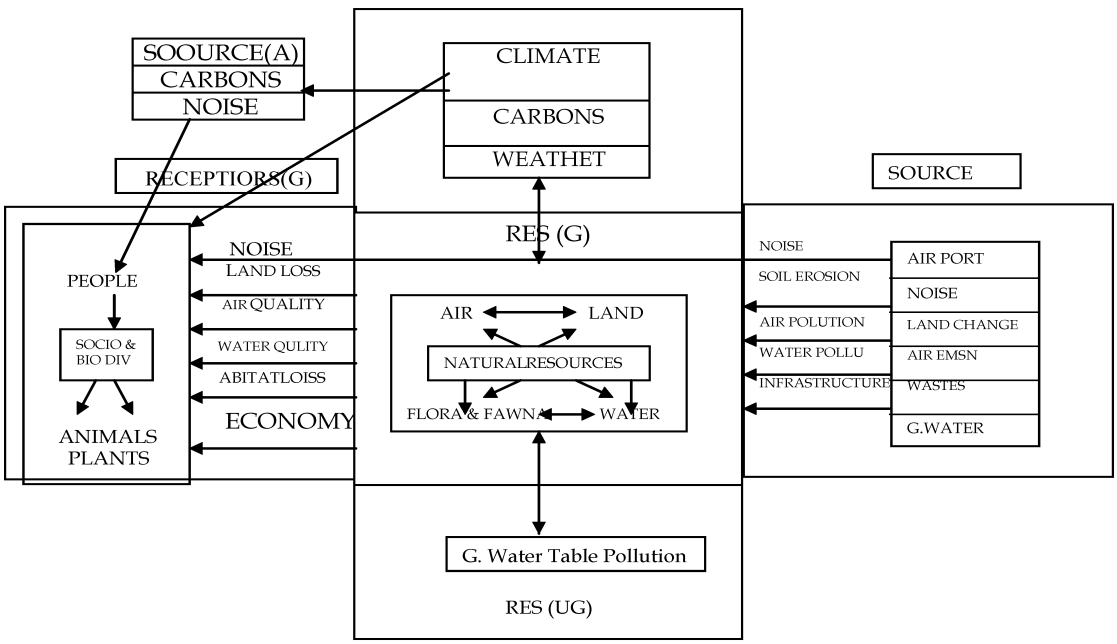


| |
|---|
| Avoid adverse environmental impact |
| Minimize and control adverse environmental impact |
| Mitigate adverse environmental impact |

## 5.1. Identification of Impacts:

Various environmental parameters are to be studied during construction and operational phase of the airport project for assessment of their impact on the surrounding environment.

The prediction process involves resources, receptors and pathways linking them. Their nature, magnitude, extent of coverage and probability of occurrence determine their relevance and significance. The pathways, sources, resources, receptors and the cause and effect relationship in the prediction of impact process of a typical airport development project in operation, is shown in **Figure 5.1.**




A:- Air
G:- Ground
UG:- Underground

**Figure 5.1 Pathways in Impact Prediction**

*Mitigation Measures and their Effectiveness:* Mitigation measures are the avoidance, reduction or remedy of significant adverse effects as explained below:

- Avoidance (e.g. at source through design),
- Reduction involves lessening the severity of an impact,
- Remedy which could include compensation accepts that there will be adverse consequences but provides means by which those consequences can be mitigated or compensated for,
- Enhancement or improvements to the environment not related to an identified impact, but where there will be a net benefit to the environment,
- Only measures that can be implemented by the applicant, either directly or indirectly, e.g. via a legal obligation with other parties for instance, should be included,
- All significant adverse impact should be considered for mitigation and specific measures put forward; and attention should be paid to all stages of the development, in particular the construction stage where there is likely to be great potential for nuisance,
- All proposed mitigating measures should be capable of enforcement,
- Mitigating measures themselves sometimes have potentially adverse impact on other aspects of environment, which will also need to be assessed in terms of significance. This needs the co-ordination between various experts who may be involved in the process.

During the identification and prediction of the impact in construction and operational phases of the airport development project, the baseline conditions are either assumed to remain unchanged or revised as per trend analysis from known data collected till reference date of construction or operation of project.

## 5.2 Prediction of Impact During Construction Phases

The activities that take place during construction phases of airport project are levelling of site, construction and erection of main airport structures like terminal buildings, runways, taxi ways, auxiliary buildings etc. , and associated equipments in operation. The impact are on land use, soil, air quality, aquatic Ecology, demography and socio-economics, access roads and public expectations. The potential primary and secondary impact on the environment, their prediction, significance and mitigation are to be discussed.

## 5.3 Prediction of Impact During Operational Phase

The potential significant impact are on physiography / topography, land use, soil quality, ambient air quality, traffic densities, water resources, water quality, biological environment, noise levels, demography & socio- economics. Secondary impact on other areas of project such as commercial aspects include funding and profits.

Baseline conditions of the potential impact studied including their trends till the time of starting of operations is considered as the base. Where no trend analysis is available, the baseline data is assumed to remain unchanged during the study period and taken as the base value of the environmental parameter. The short term (24hrly), incremental value of the environmental parameter arising due to the development of airport is predicted qualitatively or quantitatively.

## 5.4 Land Environment

### *Anticipated Impact*

The impact of the activities in the area on the land is to be clearly identified. Some of the impact include:

- Fuel storage and handling (delivery, storage and use of fuel for aircraft and other vehicles)
- Aircraft and vehicle maintenance,
- Waste burial, spillage, burning activities, fly tipping etc.
- Fire training, use of surfactants, etc.

### *Mitigation Measures*



Mitigation measure should be clearly indicated and some of these include

- Transfers of fuels during refuelling operations, leak detection on underground pipes, containment of any surface spillage are to be monitored
- Aircraft maintenance, sensitivity of the location where activities are undertaken, and control of runoff of potential contaminants, chemicals etc are to be properly implemented and reported.
- Proper drainage systems, emergency containment in the event of a major spill during monsoon season etc are to be provided for.

The mitigation measures proposed during construction and operational phases, for impact on topography if any is to be detailed out. The various structures and associated Landscape when planned will tend to improve the aesthetic appeal of the site. Tree plantation along the perimeter of the project site will further improve the appeal. The plantation species should be carefully chosen to avoid bird nesting and to improve pollution control and noise control measures.

## 5.5 Water environment

### *Anticipated Impact*

The main users of water include:-

- aircraft and vehicle washing
- aircraft potable water supply
- catering facilities
- toilets / laundries / cleaning fluids / and other domestic facilities

Maximum use of fresh water is for dwelling units, having colony, domestic traffic, Flight catering etc., The conservation measures for drinking water and ground water resources will reduce the impact on water resources drastically. Use of water from STP and Rainwater harvesting plant for green belt development / Tree plantation and for cooling plants will further reduce the burden on fresh water. Reuse of the waste water from these is to be planned for refills in tanks meant for fire fighting.

### *Mitigation Measures*

Measure for mitigating the run off from the landscape area is to route it to rainwater harvesting structures for further use in fire fighting operation, cooling plants and air conditioners after treatment. This will also recharge the ground water table. The run off from paved structures like

Runways, Taxiways, can be routed through drains to oil separation tanks and sedimentation basins before being discharged into rainwater harvesting structures. Two lines of water supply - potable (fresh) and non-potable (treated); are to be incorporated in the project design for the benefit of end users, appropriately.

Storm water drains are to be built for discharging storm water from the air-field to avoid flooding /water logging in project area during monsoon season / cloud bursts.

## 5.6 Air Environment

### *Anticipated Impact*

Short-term impact on ambient air quality due to air emissions from multiple volume sources (from moving source) such as aircrafts, surface vehicles and point sources such as DG Sets are predicted using relevant models. The model input data are the emissions from aircraft calculated on the basis of ICAO data, emissions from vehicles (Table 5.1 to 5.3) and emissions from DG Stack (Table 5.4).

For the short-term simulations for volume and point emission sources, the concentrations are estimated around numerous receptors to obtain an optimum description of variations in concentrations over the site in 10km radius covering 16 directions. The incremental concentrations are estimated for the study period representing pre-monsoon. The isopleths of these pollutants dispersion values are to be plotted, studied and compared with standards specified by CPCB for 24 hourly values. The maximum incremental Ground Level Concentrations (GLCs) due to the airport project for SPM, SO2, NOx, CO and HC are superimposed on the maximum baseline concentrations of the respective pollutants recorded during the study period to arrive at the likely resultants, concentrations after implementation of the project and the resultant concentrations are to be presented in tabular form (tables 5.5 to 5.7). The values are compared with CPCB standards.

From the projected air traffic figures for different types of aircraft for a given period (Table 1.3), the emissions from the aircrafts and point sources, 24 hourly short term incremental concentrations of air pollution, the total pollution load from domestic and international traffic for each successive year for NOx, CO & HC can be computed. The same for domestic and international traffic depending on aircraft type can also be computed.

### *Mitigation Measures*

Mitigation measures for emissions from operational sources as introduced by ICAO are as follows:-

- Low fuel / emission aircraft departure procedures,
- Continuous Descent Approach and low power- low drop techniques,
- Design the airports to minimize aircraft holding and taxiing times
- Avoid Aircraft queuing on the ground,
- Avoiding unnecessary use of aircraft auxiliary power units,
- Taxiing management (e.g. towing and single engine taxi),
- Increasing the use of public transport,
- Encouraging staff to "car share "to use more sustainable transport access,
- The use of electric vehicles or less polluting fuels (liquid & natural gas),
- Use less polluting fuels in airport buildings,

- Ensure adequate vehicle maintenance,
- Energy management in buildings and for air field systems,
- Fugitive emission controls.

All these can contribute to reducing air quality related emissions, whilst at the same time, deliver in other economy benefits. For operational measures however, there may also be trade - offs with environmental capacity and noise which is described in the "Alternative's "analysis.

### *Air Quality Modelling for Surface Traffic Outside Airport Area*

The baseline study on traffic volume outside the airport area and the observed speed is to be carried out. The anticipated increase in traffic due to project in terms of PCU (Passenger Car Units) / day is also shown in table, as per Indian Road Congress (IRC) conventions. The IRC recommendations are,



| Road category | Max PCU / day |
|---|---|
| 2-Lane Roads (7-m) with earthen shoulders | 15000 |
| 4-Lane Highway with earthen shoulders | 35000 |

Based on above, the existing peak hour traffic (in PCUs) is added to the proposed peak hour traffic (PCUs) to arrive at the total traffic in PCUs. This is verified for the adequacy of road capacity and suitable decisions are taken for widening the roads.

Mitigation measures include the increase in use of public transport and thereby reduce the emissions from vehicular transport. Review of the use of and fuels to power airside vehicles is to be undertaken at regular intervals.

## 5.7 Noise Environment

### *Anticipated Impact*

Noise sources associated with airports are

- Aircraft noise - generated by aircraft in the air and during takeoff and landing
- Ground noise - ground based activities due to taxiing of aircraft, ground running of engines, auxiliary power units, ground service vehicles etc.

***Noise Level Prediction:*** Noise during operational phase is generated by aircrafts, DG Sets and vehicular traffic. However, the latter two are localised while the aircraft noise is significant due to its movement over wide area. Suitable model may be chosen (Table 5.8). The model should calculate changes in noise impact resulting from new or extended runways, new traffic demand and fleet mix, revised routings and airspace structures, alternative flight profiles and modifications, and other operational procedures like reverse thrust. Noise contours showing the areas and the number of dwellings exposed to various aircraft noise levels are to be shown clearly.

Precise information on number of aircraft, types of aircraft, distribution of flights during the day and night are to be considered. In the absence of this information, the data is taken from peak traffic forecast of aircraft movement as per format in Table 5.8. Night time values are to be computed with additional penalty of 10 dB (A)

Lmax values are considered because it measures maximum sound pressure level occurring during a certain period of time during a single noise event. In practice, Lmax can identify serious noise

problems arising from short lived noise events, which are not picked up by Leq. It is to be borne in mind that the study is for worst case on the assumption that peak hour estimates are occurring at all hours of the day. Also effect of mitigation measures are not considered in the model, which further reduces the noise impact during actual operation. The results are compared with CPCB standards for various locations.

### *Mitigation Measures*

ICAO requirements to noise management at airports are to be followed. Some of these include reduction of noise at source (Compared to standards), land use planning, restrictions on the use of the noisiest aircrafts.

The mitigation measures adopted are a combination of change in aircraft engine / air frame design and change in air traffic procedures for reduction of aircraft noise impact at operational source. Acoustic enclosures for DG sets, noise barriers for ground- run bays, ear plugs for operating personnel are the other mitigation measures for noise impact due to ground sources. These measures gave excellent results in the last two decades world over but fell short of expectations in recent times due to rapid growth in air traffic. Rewards for using noise free routes and penalties for flouting it is one method being used in other countries. This may involve trade-offs as the fuel consumption in flying through longer routes may increase. Acquiring land in the funnel zones along take off and landing paths where noise impact is more is another adopted method in some countries. Payment of compensation to residents in approach path for bearing with aircraft noise is yet another measure adopted by international aviation agencies.

In the Indian context, new generation aircraft of reduced emissions to air are not able to operate in majority of airports due to their large size and requirement of additional length of Runway. Expansion and modernisation of these airports can make them operate at these airfields and bring down air emissions at busy airports by de-congesting traffic over them.

The noise preferential routes which the aircraft overfly the least populated areas after takeoff and before landing are to be suggested. Night flying policy to limit the number of flights and amount of noise generated during this most sensitive time is to be formulated and calculated. Mitigation measures could also include introduction of higher landing fees for noisy aircraft and for night landing in threshold cases could be considered.

## 5.8 Biological Environment

### *Anticipated Impact*

Based on the biological species found in the area, the biological value of the species found in the study area is to be assessed. This assessment will help in the development of landscaping which forms one of the important mitigation measures.

### *Mitigation Measures*

A biological action plan can help in the planning of the landscaping activities of the airport area. Also proper selection of plant species to avoid bird nesting can help in minimizing bird strikes in the airport area. Proper Landscape management plans are to be identified for the airport area.

## 5.9 Socio-Economic Environment

### *Anticipated Impact*

An assessment is to be made on the impact of the airport activity on the archaeology of the region. If it is found that the existing archaeology would be affected then a complete assessment of the potential effects is to be made. The document should be supported by photographs of elevations, architectural details and contextual photographs.

It is important that the cultural heritage of the region be highlighted in all international airports. This would enlighten the visiting population about the cultural and historical values of the region.

Impact on Occupation Health: Air pollution due to emissions of PM, NOx, SO2, HC and noise generation will effect the health of employees.



### *Mitigation Measures*

Employees working in high noise zones are to be provided with health protection devices like earplugs / ear muffs. Air pollution control measures are to be adopted. Noise control measures such as noise absorbing building material in closed buildings, noise barriers in Ground run bays, Engine caps over DG sets etc., are to be ensured. Health camps both for employees and local populations are to be conducted.

## 5.10 Waste Management

Airports produce a large quantity of wastes from a wide variety of sources including:

- in-flight wastes
- scrap wastes
- oils and solvent, components from aircraft maintenance
- catering wastes
- domestic and office wastes
- textile, plastic, rubber and metal from aircraft refurbishment

The wastes have to be managed after segregation and identifying the method of management. Recycling of wastes such as paper, glass (produced from terminals and aircraft caterers), metal (at aircraft maintenance site), plastics (from aircrafts, terminals and offices), wood, waste oil and solvents (from maintenance and engineering operations), kitchen wastes and vegetable oils (from caterers) is to be effectively carried out.

After initiating the mitigation measures in construction phase, the solid waste is of importance to the soil in operational phase. The oily sludge from ETP and garbage are to be disposed off.

## 5.11 Energy Considerations

Airports are significant resource users in terms of energy consumption during the operational and construction phases. The main use of energy in airports include

- aircraft and vehicles,
- construction activities
- heating, ventilation and air conditioning systems

- lighting, both externally, (runway, airfield and roads) and internally (terminals, offices and other buildings)
- passenger and baggage handling facilities

This requires considering the use of potential alternative energy sources. This could include energy generation on-site, use of alternative energy fuels, construction of green building in case of new airports, installing low energy lighting systems within the terminals and office spaces etc.

# ENVIRONMENTAL MONITORING PROGRAMME

## 6.0. General

This includes the technical aspects of monitoring the effectiveness of mitigation measures (including measurement methodologies, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules). The details include summary matrix of environmental monitoring during construction and operation stage; requirement of monitoring facilities and frequency, location, parameters of monitoring; compilation and analysis of data; comparison with base line data and compliance to accepted norms and reporting system and plantation monitoring programme.

## 6.1 Post Project Monitoring



(a) A technical plan which spells out in detail the methodologies for measurement, the required frequencies of measurement, the planned location of measurement, data storage and analysis, reporting schedules and emergency procedures, and

(b) Detailed budgets and procurement schedules for, necessary equipment and supplies, technical and administrative manpower.

The environmental monitoring needs to include

- Air pollution and meteorological data
- Compilation of emission inventory to quantify airport sources and the contribution to regional emissions
- Compilation of the emission inventory for aircraft sources should be undertaken.
- Storm water drain and check dams may be constructed to arrest the flow of silt loads emanating from airport during monsoon season.
- Ground water down stream of airport will be monitored. Heavy metal monitoring in surrounding wells and lakes should be taken up if necessary.
- Noise level monitoring by online integrated noise meters within airport premises continuously. This meter will be connected to central monitoring station where all the data is stored and processed.

It shall also cover different statutory returns/ compliance reports to be submitted such as:

- Submission of half yearly compliance report in respect of the stipulated prior environmental clearance terms and conditions in hard and soft copies to the regulatory authority concerned, on 1st June and 1st December of each calendar year
- Submission of environmental statement for the financial year ending 31st March to the concerned regulatory authority on or before 30th September every year
- Submission of Water Cess returns in Form 1 as per Rule 4 (1) of Water (Prevention & Control of Pollution) Cess Rules 1978 on or before the 5th of every calendar month

# 7

# ADDITIONAL STUDIES

## 7.0 General

TOR to be adopted for airports as commonly applicable is prepared and attached to this manual as Annexure 1. It may however, be necessary to consider specific issues as applicable to individual projects. The EIA report and EMP should therefore address such issues also.

## 7.1 Items Identified by the Proponent

The proponent may be able to identify issues beyond those included in the common TOR as may be specifically considered by him important from environmental point of view for the proposed project or site selected. In such cases the proponent shall include such issues as additional studies under TOR and pursue them in the EIA study after the regulatory authority approves TOR.



## 7.2 Items Identified by the Regulatory Authority

During the scoping process, the regulatory authority may direct specific issues, beyond those included in the TOR proposed by the proponent, as may be specifically considered important from environmental point of view. In such cases the proponent should pursue those issues as additional studies in the EIA report after the regulatory authority approves TOR.

## 7.3 Items Identified by the Public and Other Stakeholders

After completion of the public consultation, the applicant shall address all the material environmental concerns expressed during the process, and make appropriate changes in the draft EIA and EMP. The final EIA report, so prepared, shall be submitted by the applicant to the concerned regulatory authority for appraisal. The applicant may alternatively submit a supplementary report to draft EIA and EMP addressing all the concerns expressed during the public consultation. A statement of the issues raised by the public and the comments of the applicant shall also be prepared in the local language and in English and annexed to the proceedings.

## 7.4 Surface Access to Airport

The aim of the study is two fold.

- Improving the efficiency of Road Access.
- Reducing the emissions of pollutants and green house gases.

### *Road Access*

Every airport does require a well-planned network of access roads. These may incorporate roads dedicated purely for airport access as well as other, non - dedicated roads. The access road network must also have sufficient capacity to cope with peak hour traffic to and from the airport. Hence, study on capacity of existing Highways leading to airport and of the proposed dedicated roads to the airport is to be undertaken. This involves,

- Study of Baseline conditions of traffic,
- Projected Demand of traffic,
- Assessment of Road capacity,

### *Reduction of Pollution & Carbon:*

The use of cars as the dominant mode for accessing airport is, coming under greater scrutiny particular with local community. Key issues include;

- More congestion, delays, unreliable journeys and road casualties,
- Emission pollutants reducing local air quality and potentially affecting the health of local community,
- Generation of additional noise associated with traffic.

To obviate these impact, decreasing the proportion of journeys to the airport made by private car with increasing the share of journeys made by other modes including busses and coaches, trains and light rail, taxis and private hire vehicles, bicycles, walking and combinations of these modes. The most effective way in which to minimise the environmental effects related to airport surface access is to reduce the level of private car use through promotion of alternate modes.

Considering the associated problems in Rail link, taxi service, the best mode of passenger pick up is through coach and Bus services. Key factors that influence the choice to travel by coach are quality and reliability of service, frequency of and provision of information out a particular service, and the time of travel from pick up to the airport.

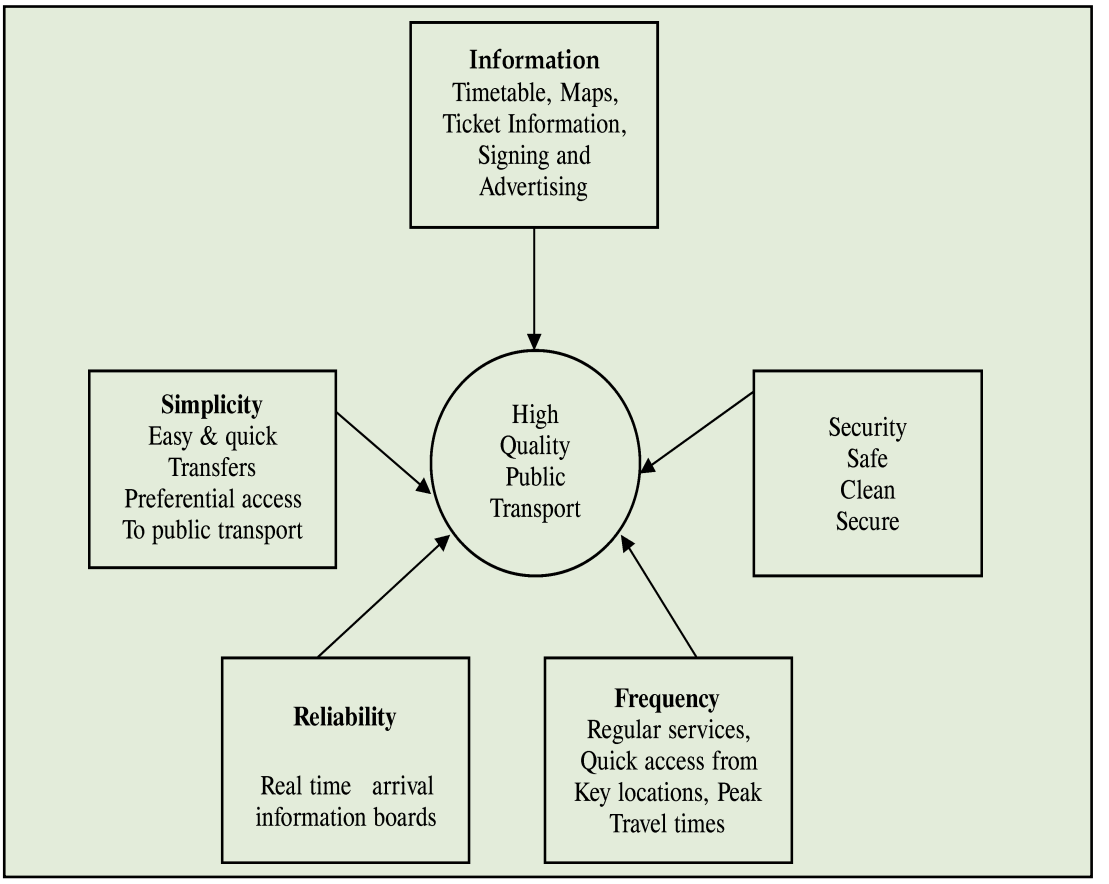



**Fig. 7.1 Key Criteria for Successful Public Transport**

### *Rail Link*

Availability of Rail link to airport is further advantageous from pollution angle, provided its option is made more attractive to passengers by -

1. Quick and early access to airport terminal from airport rail station,
2. Discount for airline passengers using trains to get to or from airport,
3. Baggage transfer service between trains and aircraft taking into account, security concerns over control of checked luggage,
4. Competitive fares and ticketing agreements between airlines and rail operators that consolidate rail and air tickets.

The use of through - ticketing to link air and rail or bus services encourages the use of mass transit over private cars because it can offer,

- Reduced connection times,
- Comfort and security from already having a ticket,
- Convenience of having tickets for all segments of a journey in a single booklet,
- Single payment for entire journey avoiding the need for foreign currency immediately on arrival and,
- Potential savings from special tariffs and promotional arrangements.



The promotion of rail services should therefore be a primary aim of the travel plan wherever possible

## 7.5 Risk Assessment

### *Hazards & Risks*

Hazard analysis involves the identification and quantification of various unsafe conditions (hazards) that may exist at an airport. Risk analysis on the other hand involves identification and quantification of risks to airport personnel, facilities and equipment due to accidents resulting from the hazards present.

At airports hazard occurrence may result in,

- Fire and / or explosion
- Leakage of flammable material
- Release of toxic material

### *Fuel*

Fuel Storage at the Airport:

Two types of fuel are stored in underground tanks.

- Aviation Turbine Fuel (ATF) including under ground Fuel Hydrant system,
- HSD for ground service vehicles and DG set.

### *Chemical Storage*

- Identification of Major hazardous units based on Manufacture, storage and import of hazardous Chemical Rules 1989 (amended in 2000) of GOI. E.g. Flammable substances, unstable substances and Toxic substances as rated in NFPA codes 49 and 345M,
- Identification of hazardous units and segments of Airports and Storage units based on relative ranking technique. Fire -explosion and Toxicity Index (FEDTI).

Preliminary Hazard Analysis for Process and Storage Areas at an airport and also for the whole airport is shown in Table 7.1. Assessment, relevance and reliability of analytical methods and framework used in risk assessment are given in Annexure 8.

Leakage of hazardous material due to accidents can be assessed by models and Maximum Credible Accident Analysis (MCAA). The out puts are damage distances of heat radiation, toxic releases, vapour cloud explosion etc.

Damage Criteria: The fuel storage and the supply pipelines may lead to fire and explosion hazards. This may release hydrocarbon, which does not contaminate soil and also is not toxic as it vaporizes slowly without leaving a residue.

Damage due to Fire from Flammable Liquid i.e. (ATF, HSD): The damage is mainly due to thermal radiation intensity and lethality is shown in Annexures 9.1 and 9.2.

Damage due to Explosion: It is sudden and violent release of energy accompanied by the generation of pressure wave which causes injury to people and damage to property and death to people in close proximity. (Boiling Liquid Expanding Vapour Explosion (BLEVE) or Vapour Cloud Explosion (VCE).

BLEVE Fire ball is combination of fire & explosion due to overheating of a pressurised vessel by primary fire.

Vapour Cloud Explosion is due to confined (in a vessel & pipeline) or unconfined explosion (in open air). The peak pressures in confined explosion reach hundreds of k Pa while in unconfined it is few k Pa.

Damage due to Hazards at ATF Store and HRD Store at Airport:

- Model simulations reveal that leakage at HRD store causing fire will be 100% lethal within 18 metres and 50% lethal with in 23 metres. Vulnerable zone within abnormal heat is within 34metres.
- BLEVE- fireball due to failure of ATF storage is 100% lethal within 72metres and 50% lethal with 111metres. Safe distance is 565metres.
- Safe distance for pool fire (leakage) at ATF storage is 436 metres and that at HSD storage is 109metres.

Design consideration for Hazardous material storage:

The implication of the above observations is that

- The location of ATF storage tank and HSD storage tank should be well within the Airfield taking into consideration the safety distance for population outside airfield, workers and equipment within airfield.

- The design consideration should be as per maximum fuel storage planned. The Dyke wall should be constructed as per standard norms for the capacity of tank keeping in view the meteorological and local factors within the airfield.

## 7.6 Disaster Management Plan

*Emergency planning* is an essential part of overall loss control programme for effective management of an accident / incident to minimise losses to people and property both in and out side the airfield.

### *Prevention Measures*

These include formulation of technical and organisational measures for

- Controlling leakage of hazardous materials out of the facility
- Implementing proactive and reactive measures against threats to the safety of personnel and property.

### *Standard Operational Procedures( SOPs) & Action Plans and Resources*

The preventive measures can be implemented successfully, provided the organisation is aware of the plan of action, the responsibilities and the requirement of resources. Hence, standard operational procedures, Action plans highlighting what is to be done and by whom and inventory of the resources required are important. These also include the discussion of role of Government organisations and those agencies under Mutual Aid Scheme.

7

### *Emergency Planning at Airport:*

The objectives of Emergency plans are to,

- Rapidly control or contain hazardous situation.
- Minimise the risk and impact of accident
- Rescue and rehabilitate affected persons and prevent damage to property.

To action this, the following are required:

- Accurate and early detection of emergency,
- Command, co-ordination and response of organisational structures along with efficient trained personnel.
- Resource availability
- Appropriate Emergency response actions,
- Effective communication facilities,
- Regular review and update of plan,
- Proper training of concerned personnel.

### *Organisational Structure*

- Airport in-charge is responsible for maintaining distribution and control of the plan and for review and revision of procedures,
- Safety in-charge is responsible for training of personnel on the drills and their adequacy,
- All employees and occupants are responsible for carrying out their responsibilities as per the plan.

### *Emergency Response at Airport*

This includes:

- Accident initiation and raising the Alarm by Emergency control centre,
- Accident evaluation and classification of on site emergency by the Airport Director.
- Declaration by the Director to initiate action for mitigation and taking over from ATC Sr. Manager for control operations.
- Off site and External Agency Notification by Director,
- Implementation of on site response actions,
- Protective actions and evaluation, co-ordination of Response Actions with External agencies, Management of emergency resources by Emergency Operations centre located at ATC through various action addressees specified in SOPs.

### *Recovery*

After termination of the emergency, the Director in conjunction with facility activities to normal management, establishes a Recovery organisation to manage those activities necessary to return to normalcy.

## 7.7 Rehabilitation and Resettlement (R&R) Plan

### *Impact on Economy & Environment:*

Rehabilitation and Resettlement covers total families displaced due to project construction and villages affected. Impact assessment and mitigation measures proposed are to be tabulated.

Detailed R&R plan with data on the existing socio-economic status of the population in the study area and broad plan for resettlement of the displaced population is to be given. The site for the resettlement colony is to be earmarked. Alternative livelihood concerns/employment are to be addressed. Rehabilitation of the displaced people, civil and housing amenities being offered and the schedule of the implementation of the project specific R&R Plan may be prepared. Details of provisions (capital & recurring) for the project specific R&R Plan may be given. These include the financial help, employment; vocational training etc; due to loss of land, jobs, profession and livelihood. The commitment of project proponent in this regard may be recorded and expenditure may be budgeted.

In addition to the benefits derived during construction phase as per implementation of R&R plan, the population will get more employment during operational phase, mainly skilled and semi- skilled jobs. The environment 5km around airport may be more urbanised with cost of living going up. However, with increase in income this is off set. All the project-affected persons should be counselled to use the 'Rehabilitation Grant' received carefully, for future settlement. Settlements may increase due to influx of people in search of employment from outside. Civic amenities will improve in terms of power, drinking water, health care, education, communication and other infrastructures.

On the other hand flight safety hazard sources such as, slaughterhouses, which promote bird activity in airport vicinity and high-rise buildings, which form obstructions for aircraft operations, may develop. New small-scale industries may crop up in the surroundings, affecting the ambient air and water quality. Awareness of these hazards " and their role in aviation will make the population realise their social responsibilities.

# 8

# PROJECT BENEFITS

## 8.0 General

This chapter should include benefits accruing to the locality, neighbourhood, region and nation as a whole. It should bring out details of benefits by way of:

- Improvements in the physical infrastructure by way of addition of project infrastructure, ancillary industries that may come up on account of the project
- Improvements in the social infrastructure like roads, railways, townships, housing, water supply, electrical power, drainage, educational institutions, hospitals, effluent treatment plants, improved waste disposal systems, improved environmental conditions, etc.
- Employment potential -skilled; semi-skilled and unskilled labour both during construction and operational phases of the project with specific attention to employment potential of local population as well as necessity for imparting any specialized skills to them to be eligible for such employment in the project on a long term basis i.e., during operational and maintenance stages of the project and
- Other tangible benefits like improved standards of living, health, education etc.



## 8.1 Socio-Economic Benefits of the Project Mainly Include

- provision of additional revenue generation in terms of foreign exchange earned from operations,
- Triggering growth in the region;
- provision of additional employment;
- development of ancillary industries and trade centres;
- improvement in quality of life, flight safety awareness and literacy of people in the area and
- promote direct foreign investment in the region due to access to international markets

9

# ENVIRONMENTAL COST BENEFIT ANALYSIS

## 9.0 General

If recommended by the Expert Appraisal Committee at the Scoping stage i.e., deciding upon the TOR, this chapter should include the Environmental Cost Benefit Analysis of the project.

9

# ENVIRONMENTAL MANAGEMENT PLAN (EMP)

## 10.0 General

The objective of Environmental Management Plan is to:

- Monitor the effectiveness of mitigation measures
- Ensure efficient operation of mitigation measures
- Establish systems and procedures for this purpose
- Take any necessary action when unforeseen impact occur

## 10.1 Components of EMP

The EMP should contain the following :

- Summary of potential impact & recommended mitigation measures. Allocation of resources and responsibilities for plan implementation
- Administrative and technical set up for management of environment
- Institutional arrangements proposed with other organizations/Govt. authorities for effective implementation of environmental measures proposed in the EIA
- Safe guards/mechanism to continue the assumptions/field conditions made in the EIA
- Environmental specifications for contractors should cover the required safeguards during the design and construction stage
- EMP to comply the standards and code of practices modified under E (P) Act 1986
- Approach towards voluntary compliance should be explained ISO 14001



## 10.2 Environmental Cell

It is desirable for the proponent to set up a separate environmental cell to oversee implementation of the EMP and evaluate the results of monitoring. Survey and analysis to be carried out periodically

The Environmental management plan should include:

- checking the final design documents to ensure they incorporate the management measures.
- Monitoring the construction and interacting with the contractor to ensure an understanding of compliance with the constraints involved with the Environmental protection or mitigation measures during construction and,
- Following construction, continuous monitoring during project operations to ensure that the project meets its environmental goals, and to initiate needed modifications to the project design or operations for this purpose.

11

# SUMMARY AND CONCLUSIONS

## 11.0 General

Summary EIA shall be a summary of the full EIA report condensed to ten A-4 size pages at the maximum. It should necessarily cover in brief the following chapters of the full EIA report.

- Introduction
- Project Description
- Description of the Environment
- Anticipated Environmental Impact & Mitigation Measures
- Additional Studies
- Project Benefits
- Important Aspects of the Environmental Management Plan and
- Important Aspects of the Environmental Monitoring Programme
- Disclosure of Consultants Engaged

# DISCLOSURE OF CONSULTANTS ENGAGED

## 12.0 General

The team of consultants engaged in the project is to be given with brief resume of team mem bers and nature of consultancy rendered. The EIA consultants shall have accreditation with Quality Control of India (QCI)/National Accreditation Board of Education and Training (NABET) as per office memorandum dated 2nd December 2009 of MoEF. This chapter shall include the names of the consultants engaged with their brief resume and nature of consultancy rendered. The consultants shall include the copy of the accreditation certificate and data provided by the other organizations/ laboratories including their status of approvals etc.

# BIBLIOGRAPHY


- Airport Planning and Environmental Strategies in Catalonia - Pere Snan Sanchez-Bulletin de la A.G.E.
- Aviation & The Environment-Lecture notes. Ian A. walz, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology. US.
- Biodiversity News. Andhra Pradesh.
- Cleary, E. and Dolbeer, R. 2005. Wildlife Hazard Management at Airports - A Manual for Airport Personnel. United States Federal Aviation Administration (US FAA) and US Department of Agriculture. Washington DC: US Departments of Transportation and Agriculture
- Environmental Assessment: Good practice, special Publication 12G CIRIA; 1996.
- Environmental assessment: law and policy: Sheate B Cameron May, London, 2nd ed, 1996.
- Environmental Guidance Manual for Airports, Nov.2006, Sustainable Aviation, UK Entec. www.sustainableaviation .co.
- Environmental Impact Assessment : an effective, management tool-Subroto Sinha. TERI information monitor on Environmental Science 3(1) : 1-7.
- Environmental Impact Assessment -Review checklist-European Commission -1994.
- Environmental Impact Assessment: Theory and practice ed. Wathern, P. (Unwin Hyman, London, 1988)
- Environmental Impact Assessment-Report by World Bank.
- Environmental Impact Assessment in Practice- Weston. J Longman 1997.
- Environmental Impact of Aviation Peter J Gray-Mullen; Edwards and Kelcey, Inc. A1 J52, Task Force on Environmental Impact of Aviation.
- European Civil Aviation Conference (ECAC). 1997. ECAC Doc. 29. Report on Standard Method of Computing Noise Contours around Civil Airports. Neuilly-Sur-Seine, France: ECAC.
- Guidelines for environmental impact assessment, institute of environmental management and assessment, 2004, UK.
- ICAO. 1993. Convention on International Civil Aviation Annexes 1 to 18 (Booklet on the Annexes to the Convention on International Civil Aviation).Montreal: ICAO.
- ICAO. 2002. Airport Planning Manual, Part2 - Land Use and Environmental Control (ICAO Document 9184). Montreal: ICAO.
- ICAO. 2005. ICAO Accident Prevention Programme. Montreal: ICAO. Available at http://www.icao.int/icao/en/anb/aig/app_20050907.pdf
- Input - output analysis-Environmental Impact Assessment M.Lenzen et al. Environ. Impact Assess.Rev.23 (2003) 263-282.
- Introduction to Environment Impact Assessment, Industry & Environment Unit, CSE.

- Local Air quality Euro control. www.Eurocontrol.int/environment/public/standard-page/air-quality.html.
- Methods Environmental Impact Assessment. Edited by Morris.P, and Therivel,R., UCL Press 1995.
- Rogers HL et al, 2002, The impact of aviation on the atmosphere
- Southern African Power Pool ( SAPP). Thermal Power Plant Projects Environmental Impact Assessment: Guidelines. Section 3, Performing the EIA -20 Dec 2001.
- The Essex Guide to Environmental Impact Assessment, 2007
- The Role of Environmental Imapct Assessment in the Planning Process" ed. Clark, M. and Herington, J(Mansell Publishing Ltd. London 1988).
- United Kingdom (UK) Parliamentary Office of Science and Technology. 2003. Postnote Number 197. Aircraft Noise. London: Parliamentary Office of Science and Technology. Available at http://www.parliament.uk/post/pn197.pdf
- Virginia Highlands Airport -Environmental Assessment Project Summary Nov 2005.
- Wildlife Hazard Management at an Airport.
- World Commission on Environment and Development (WCED). Our Common Future. Oxford. Oxford University Press 1987.
- www.airquality.co.uk accessed March 2009
- www.caa.co.uk accessed December 2008
- www.dft.gov.uk accessed January 2009
- www.highways.gov.uk accessed December 2008
- www.hse.gov.uk accessed January 2008
- www.iema.net accessed February 2009
- www.ioa.org.uk accessed July 2008
- www.naei.org.uk accessed May 2009
- www.sustainableaviation.co.uk accessed July 2009
- www.who.int/en/ accessed June 2009
- http://europe.osha.eu.int/good_practice/risks/ds/oel/ accessed December 2008

# GLOSSARY

**Airfield**

An area of ground where aircraft can take off and land

**Aerodrome**

A defined area on land or water (including any buildings, installations,and equipments) intended to be used either wholly or in part for the arrival, departure and surface movement of the aircraft

**Aerodrome Traffic Circuit**

The specified path to be flown by aircraft operating in the vicinity of an aerodrome

**Aerodrome Taxi Circuit**

The specified path of aircraft on the manoeuvring area during specific wind conditions

**Airport**

An area consisting of a set of runways and buildings where non-military aircraft can take off and land

**Airbase**

Base for military aircraft

**Airport Reference Point / (Aerodrome Reference Point) (ARP) :**

A point on the airport designated as the official airport location.

**Apron**

A defined area on a land aerodrome intended to accommodate aircraft for the purposes of loading and unloading of the passengers, mail or cargo, fuelling,parking or maintenance

**Apron Taxiway**

A position of a taxi way system located on an apron and intended to provide a through taxi route across the apron

**Aircraft Taxi Lane**

A portion of an apron designated as a taxiway and intended to provide access to aircraft standards only

**Aircraft**

Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against earth's surface

**Air Traffic**

All aircrafts in flight or operating on the manoeuvring area of an aerodrome

### Air Traffic Service

A generic term meaning variously, flight information service, alerting service, air traffic advisory service ( air traffic control service, approach control service or aerodrome control service )

### Approach Funnel

A specified airspace around a nominal approach path within which an aircraft approaching to land is considered to be making a normal approach

### Airway

A control area or portion thereof established in the form of a corridor equipped with Radio navigation aids

### ATS Route

A specified route designated for channeling the flow of traffic as necessary for the provision of air traffic services

### Final Approach

That segment of an instrument approach procedure in which alignment and descent for landing are accomplished

### Glide Path

A descent profile to determine for vertical guidance during final approach

### International Civil Aviation Organization (ICAO)

A specialized agency of the United Nations whose objective is to develop the principles and techniques of international air navigation and to foster planning and development of international civil air transport

### International Airport

Any airport designated by the contracting State or whose territory it is situated as an airport of entry and departure for international air traffic where the formalities incident to customs, immigration, public health animal and plant quarantine and similar procedures are carried out

### Instrument Landing System (ILS)

It is designed to provide an approach path for exact alignment and descent of an aircraft on final approach to a runway

### Landing Area

That part of a movement area intended for the landing or takeoff or aircraft

### Movement Area

That part of an aerodrome to be used for the takeoff, landing and taxiing of aircraft, consisting **of** the manoeuvring area and the Apron(s)

### Rapid Taxiway

A taxiway connected to a runway at acute angle and designated to allow landing aeroplanes to turn off at higher speeds than are achieved on other taxiways and thereby minimizing runway Occupancy times

### RADAR: (Radio Detection and Ranging)

It is a surveillance system whereby radio waves are transmitted into the air and then received when they have been reflected by an object in the path of the beam to detect its range and direction

### Runway

A defined rectangular area on land aerodrome prepared for the landing and takeoff of aircraft

### Taxiing

Movement of an aircraft on the surface of an aerodrome under its own power, Excluding takeoff and landing

### Taxiway

A defined path on a land aerodrome established for the taxing of aircraft and intended to provide a link between one part of the aerodrome and another including aircraft stand taxilane, apron taxiway and rapid exit taxiway

### Touchdown

The point where the normal glide path intercepts the runway.

# TABLES

## Table 1.1 Air Traffic Projections

| | | |
|---|---|---|
| Existing Traffic in the year: ---------- | | |
| Domestic traffic | = | A (Embarking+ Disembarking +Potential passengers from other modes of transport) - B (Transfer from Domestic to International) |
| International traffic | = | C (Embarking + Disembarking + potential passengers from other modes of transport) + B (Transfer from Domestic to International) |

## Table 1.2 Forecast Traffic

| Forecast Traffic | Annual Growth Rate Rate | Period | Forecast at the end of Period - |
|---|---|---|---|
| Domestic | R% | n yrs | (A-B)(1+R/100)*n |
| Inter | S% | n yrs | (C+B)(1+S/100)*n |

## Table 1.3 Peak Demand in Aircraft Movement Per Annum from The End of Period

(a) Large Aircraft (Type/Capacity) - 747/360 A330/260

(b) Medium Aircraft (Type/Capacity) - A320/165 B737/145

(c) Forecast Passengers International - Y
During the year Domestic - X

(d) number of days during peak month of traffic - n

| Sl No | Forecast Details (ICAU) | International Aircraft B/747, A-330, A-320 | Domestic Aircraft A-330, A-320, B-747 |
|---|---|---|---|
| 1 | Capacity Average | 255 | 190 |
| 2 | Average Occupancy | 60% | 66% |
| 3 | Average Seats per air craft | 153 | 125 |
| 4 | No. of operations per Annum | Y/153 | X/125.4 |
| 5 | Peak Month operation (Dec)@ 10% of (4) | Y/153x0.1 | X/125.4x0.1 |
| 6 | Operations in Average Day of Peak Month (ADPM) | $Y/153 \times \frac{0.1}{n}$ | $X/125.4 \times \frac{0.1}{N}$ |
| 7 | Peak hour operations @ 20% of ADPM | $Y/153 \times \frac{0.1x0.2}{n}$ | $X/125.4 \times \frac{0.1x0.2}{n}$ |
| 8 | No of flight per million passengers during peak hour of the year (Y = 1000000) | 131/ n | 160/n |
| 9 | Peak hour passengers @ 23% of ADPM per International flights and 20% of ADPM per domestic flights | Y/n x 0.1 x 0.23 | X/n x 0.1 x 0.20 |
| 10 | No of passengers during peak hour per million passenger during the year | 23002/n | 19995/n |

## Table 1.4 Forecast Cargo Traffic (Y = 1000000)

| | | | | | |
|---|---|---|---|---|---|
| Existing Cargo in MT for Export | = | D + (Actual) | E (Potential) | = | P (MT) |
| for Import | = | F + (Actual) | G (Potential) | = | Q (MT |

| Period | Annual Growth Rate | | Quantity in MT | |
|---|---|---|---|---|
| | Export | Import | Export | Import |
| T years | K% | L% | $P\left(1+\frac{k}{100}\right)^{t}$ | $P\left(1+\frac{L}{100}\right)^{t}$ |

## Table 2.1 Key Design Features of Proposed Airport

| Facility | | | Key Design Features |
|---|---|---|---|
| 1 | Civic Airport | | |
| | (a) | Runway | Description, Handling Capacity, Restrictions, Nav aid |
| | (b) | Taxiway | Description, emergency usage |
| | (c) | Rapid Exit Taxi | Special feature if any |
| | (d) | Other Taxi ways | Special feature if any |
| | (e) | Parking Apron | Facility for Latest new air craft |
| | (f) | Maintenance | Special Features |
| 2 | Terminal Building | | Area, Sealing Capacity in various phases, Aerobridges, security system, elevators Escalators, Walkalators, Baggage handling system, Flight info system, CCTV, Air conditioning. |
| 3 | Cargo Terminal | | Logistics and redistribution |
| 4 | Communication, Navigation and Surveillance systems | | ILS, Lighting system, RVR measuring. |
| 5 | Infrastructure | | Main Access Road, Other Access Road, Aside Road, Rail Link, Water and Power Supply |
| 6 | Fuel Farm | | Fuel farm design in collaboration with others |
| 7 | Car Park | | Features for handling Peak capacity |
| 8 | Other facilities | | Housing, maintenance workshops, offices, crash Rescue & Fire Fighting Station. ATC control tower, Ware house for Retail depot. |
| 9 | Miscellaneous | | Ground Handling Equipment, CRF Eqpt, Fire detection alarm and Fire Hydraulic, Met equipment |
| 10 | Airport Management Systems | | Monitoring of all operational, security and lighting equipment. Automation of storage and Retrieval systems. |

## Table 2.2 Features of Proposed Airport

| Sl No | Description | Details |
|---|---|---|
| 1 | Runways, Length, Width, Orientation and NAV AIDS & Nos | |
| 2 | TAXI WAYS - Full length parallel length & Width & Nos. | |
| 3 | Taxi ways - Rapid Exit Length, Width & Numbers | |
| 4 | Other Taxi ways - Apron Taxi way, cargo Taxiway, Main Taxi way, General Aviation | |
| 5 | Apron Facilities, Aero Bridges, Cargo, Remote Parking, VIP, Maintenance and isolation | |
| 6 | Cargo Terminal - Capacity (MTPA) | |
| 7 | Passenger Terminals - domestic, International, Capacity, area, Peak hour Capacity | |
| 8 | Maintenance Hangars | |
| 9 | Car Park | |
| 10 | Access | |
| 11 | Ancillary Projects - Fuel Arm, Logistics Center, Hotel, Convention Center, Free Trade zone, Restaurants, Aviation Training, Flight Catering Centre, aircraft Maintenance etc. | |

## Table 4.1 Physical Properties of Soil

| Station Code | Colour | Texture | Water Holding Capacity (%) | Porosity (%) | Sand (%) | Salt (%) | Bulk Density gm /cc | Permeability ml |
|---|---|---|---|---|---|---|---|---|
| **S1** | | | | | | | | |
| **S2** | | | | | | | | |
| **S3** | | | | | | | | |
| **S4** | | | | | | | | |

## Table-4.2 Chemical Properties of Soil

| Parameters | Samples | | | | | |
|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S4 | S5 | S6 |
| **pH** | | | | | | |
| **Potassium** | | | | | | |
| **Sodium** | | | | | | |
| **Sodium Absorption Ratio** | | | | | | |
| **Cat ion exchange capacity** | | | | | | |

### Table No. 4.3 Description of Ground Water Surface Water Sampling Locations

| Station No. | Location | Distance & Direction from project area | Project area/ study area | Environmental setting |
|---|---|---|---|---|
| GW | | | | |
| | | | | |
| | | | | |
| | | | | |

### Table No. 4.4 Description of Ambient Air Quality Monitoring Stations

| Station No. | Location | Distance & Direction from project area | Project area/ study area | Environmental setting |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

### Table No. 4.5 Analysis of Ambient Air Quality

| Monitoring Station Category (R,I,S) | Category of Station | Min. | Max. | Mean | 95 Percentile | Min. | Max. | Mean | 95 Percentile | Min. | Max. | Mean | 95 Percentile | Min. | Max. | Mean | 95 Percentile | Min. | Max. | Mean | 95 Percentile |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
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R - : Residential Area
I - : Industrial Area
S - : Sensitive Area

## Table No. 4.6 Description of Noise Monitoring Stations

| S. No | Locations | Class* | Average Day noise level (dBA) | Average Night noise level | Day time (6.00 A.M. to 10.00 P.M) Standard (Leq in dBA) | Day time (10.00 P.M. to 6.00 A.M) Standard (Leq in dBA) | Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |

*Industrial area/ Commercial area /Residential area /Silence zone

## Table 4.7 Demographic Profiles of the Villages in the Atudy Area

| Sl. No. | Demographic Feature | Study Area | Share in total Population (%) |
|---|---|---|---|
| 1.0 | Total Population | | |
| 2.0 | Households | | |
| 3.0 | Occupation | | |

## Table 4.8 Other Infrastructural Facilities Available in the Study Area

| Sr. No. | Name of the village | DWF | Tp | W | T | TW | HP | R | C | L | S | O | PO | TO | PT | P | B | RS | NW | CB | CoB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Note:

DWF : Drinking Water Facility
Tp ; Tap
W : Well
T : Tank
TW : Tube Well
HP : Hand Pump
R : River
C : Canal
L : Lake
S : Spring
O : Others
PO : Post Office
TO : Telegraph Office
PT : Post & Telegraph Offices
P : Phone
B : Bus
RS : Railway Service
NW : Navigable Waterways
CB : Commercial Bank
CoB : Co-operative Bank

**Table 5.1 Emission From Petrol Driven Vehicles ( 2/3 Wheelers and Light Duty Vehicles LDVS) (With Reference Mass >350 kg, 1020-1250 kg and speed 40 km/hr)**

| Pollutant | MoEF Standard gm/km (1) | | Emissions g/s/vehicle=1xspeed/3600 (2) | | Total Emissions g/s=2xvehicles Nos. (3) | |
|---|---|---|---|---|---|---|
| | 2/3 wheeler | Light Duty | 2/3 wheelers | LDVS | 2/3 Wheelers | LDVS |
| CO | 40 | 19.7 | | | | |
| HC | 15 | 2.7 | | | | |

Co - Carbon Monoxide
HC- Hydrocarbon

**Table 5.2 Emission from Diesel Driven Vehicles (Trucks/Busses and speed 30 km/hr) (Reference from 125 HP Engine and speed 30 km/hr) Format**

| **Pollutant** | **MoEF Standard gm/km vehicles (gm/kwh) (1)** | **Emissions (g/s vehicle) 1x HP x 0.746/3600 (2)** | **Total Emissions (g/s) = 2 x vehicles Nos. (3)** |
|---|---|---|---|
| CO | 19 | | |
| HC | 3.8 | | |
| $NO_x$ | 18 | | |

$NO_X$ - Oxides of Nitrogen

**Table 5.3 Total Emissions From All Vehicles (From Tables 5.1, 5.2 )**

| Parameter / Type of vehicle | Units | Value | | |
|---|---|---|---|---|
| | - | Petrol Driven | | Diesel Driven |
| | g/s | 2/3 Wheelers | LDVS | Trucks/Buses |
| CO | " | | | |
| HC | " | | | |
| NOx | " | Not specified | Not specified | |

**Table 5.4 Emissions From Dg Stack**

| Parameter | Emission rate (gm/sec) |
|---|---|
| Particulate Matter | Emission Rate (gm/sec) = Emission limit (mg/Nm3) * flow rate (Nm3/hr) |
| CO | Emission Rate (gm/sec) = Emission limit (mg/Nm3) * flow rate (Nm3/hr) |
| NOx | Emission Rate (gm/sec) = Emission limit (mg/Nm3) * flow rate (Nm3/hr) |
| SO2: | Emission rate (gm/sec) = Stack exit gas flow rate (Nm3/hr * percentage of Sulphur in HSD x HSD density x Conversion factor 64/32 |

SO2 -Sulphur dioxide

## Table 5.5 Resultant Concentrations Due to Incremental GLC (Base line value + Predicted Airport Value)

| Pollutant | Max AAQ Concentrations Recorded during the Study Microgram/$m^3$) | Predicted Incremental (Max) Concentrations due to Airport Microgram/m3 (Aircraft+DG+Traffic in Airport) | Resultant Concentration (Microgram/$m^3$) during Post Project Scene (Max) |
|---|---|---|---|
| PM<br>$SO_2$ | | | |
| $NO_x$ | | | |
| CO | | | |
| HC | | | |

PM - Particulate Matter(10, 2.5).

## Table 5.6 Record of Daily Traffic at Site

| Date and Location | Traffic Category and AV Speed | | | | | Passenger Car Units (PCU) per days |
|---|---|---|---|---|---|---|
| Truck/Bus (MF= 3.0) | LCV (MF=1.0) | Car/Jeep (MF=1.0) | MAV (MF=3.0) | 2/3 Wheeler (MF=0.5) | Others Tractors (MF=3.0) | (Factors Truck 3.0, Tractor 3.0; LDV-1.0, 2/3 wheelers 0.5) |
| | | | | | | |

MF - Multiplication factor

## Table 5.7 The Peak Daily Traffic Case

| Aircraft | Departure/Day | Approaches/day | Distribution of both departure and approach in % | | |
|---|---|---|---|---|---|
| | | | Day Time (0700-1900) | Evening (1900-2200) | Night (2200-0700) |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Peak Daily Traffic : Domestic = Nos | | | International = Nos | | |
| | | | | | |

### Table 5.8 Post Project Noise Levels

| Location of Noise Measurement | Pre Project Noise Level (Leg) dB(A) | | Incremental Noise Levels Due to Project* (L max) dB (A) | Post Project Noise Levels (Leg) dB(A) | |
|---|---|---|---|---|---|
| | Day | Night | | Day | Night |
| | | | | | |

Night time values are computed with additional penalty of 10 dB (A)

* Integrated Noise Model (INM) version 6.0 developed by Federal Aviation Administration (FAA) office of environment and energy USA may be used till CPCB / MoEF come out with their recommended model.

### Table 7.1 Preliminary Hazard Analysis For Process And Storage Areas And For Whole Airport

| Source | Process | Potential Hazard | Provisions |
|---|---|---|---|
| DG Set | Production of Electrical Energy | Fire hazard in Lube oil system, cable gallery short circuit | Standard Cables to be used, Fire detection system to be used |
| Power Transfer unit | | Fire and explosive | -do- |
| Switch Yard Control Room | 220 KVA switch yard | Fire | -do- |
| ATF & HSD Storage Area | Fuel Storage for Aircraft, ground vehicles | Fire & Explosive | Precautions as per TAC, OISD to be followed. Fuel Hydrant system for Aircraft refuelling. Fire Detection alarm system. |
| Compressor House | Airport operation | Governor failure due o the failure of pins and springs leading to opening of safety valves & source ignition | Design precautions to be followed in manufacture and erection. Fire Detection Alarm system to be used. |
| Buildings | Electrical short circuit Eventually source ignition | Fire | All electrical fittings and cables will be provided of standard quality. All motor starters to be flame proof. |
| Chemical Store | Inflammable chemicals in Stores | Fire in Storage Areas due to inflammable nature of chemicals | Fire extinguishers at potential points. Fire Hydrant network as per TAC guidelines. Fire detection system. |

# ANNEXURES

# Annexure 1
# Terms of Reference (TOR) for environmental impact assessment of AIRPORTS

## Objectives

Terms of Reference (TOR) for preparation of Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for Airport Development / Expansion / Modernization are prerequisites for obtaining Environmental clearance as per the EIA notification of September 2006 as amended December 2009 by Ministry of Environment and Forests (MoEF) GOI. They have been devised to improve the quality of the reports and make decision-making process transparent and easy. TOR will help the project proponents and consultants to prepare the report with relevant project specific data, which are precise, concise and easy to comprehend. TOR for Airport Development/ Expansion/ Modernization is expected to cover all environmental related features.

## General Information

Airports are classified as international, domestic with customs facilities and domestic airports. Aviation compared to any other mode of transport, has grown rapidly and made significant contribution to the economic development of countries world over. Development / expansion / modernisation of airport facilities (referred as Project) are a right step towards meeting that end. Associated with the economic benefits, they may also create adverse impact on the surrounding environment during construction, operational and post operational phases of the project. These include pollution in land, air, water, noise, biological, socio-economic and health environments. The project development and operation should therefore be planned with careful consideration of their environmental impact. To minimise these adverse effects that may be caused by the project and to identify suitable alternate methods /sites; techniques of Environmental Impact Assessment became necessary.

## 1.0 Introduction

Airport development / expansion / modernisation is listed at Para 7 (a) of the schedule of list of projects dealing with physical infrastructure in MoEF notification as amended December 2009. It is a category 'A' project as stipulated in the EIA notification 2006. Prior environmental clearance before starting any Construction work or preparation of land except for security the land is mandatory for this project.

This chapter shall cover purpose of the project, details of project proponent, brief description of the project; name, nature, size, location of the project and its importance to the region.

Profile of the Project Proponent, name and contact address, Implementing Organization, Organizational Chart, Project consultants etc., should be mentioned clearly.

Land description/ plot/ survey / khasra nos, village, tehsil, district, state & extent of the land must be mentioned clearly.

Description of existing National/State environmental laws/ regulations on the proposed activity with annexure giving their references is to be brought out clearly.

Any litigations pending against the proposed project site and / or any directions or orders passed by any court of law against the project are to be detailed out.

In case of expansion/ modernization of the project, the environmental compliance status for the existing project should be explained.

In the beginning of the EIA report, the page numbers of various chapters, sections and sub-sections, tables, appendices, drawings and figures etc., with titles should be clearly indicated.

## 2.0 Project Description

The chapter should contain the broader details of the basic activities, location, lay out and implementation schedule of the project.

Background of the project may contain the following:

- Purpose of the project, goals and objectives of the proposed project
- Significance of the project both at local and national level and its contribution to national economy.
- Relevance of the project in light of the existing development plans of the region.
- Information on the proposed activity in the Indian context and its overall function.

***Project details should include information related to:***

- Project coverage, master plan, phasing and scope.
- Estimated cost of development of the project, environmental costs, funding agencies, whether governmental or on the basis of BOO or BOT etc
- Resources, manpower, time frame etc required for the completion of the project.

***Essential Toposheets / Maps to be provided with TOR application***

### Topographical map

A map of the topo sheet of the study area (project area and area 10 km around its boundary) delineating the major topographical features such as land use, drainage, locations of habitats. Major constructions including roads, railways, pipelines, major industries, if any in the area are to be clearly shown.

A map of the study area covering aerial distance of 15 km from the proposed project boundary delineating environmental sensitive areas as specified in Form I of EIA notification of Sept 06.

### Remote sensing imagery

Land use map of the study area to 1: 25,000 scale, based on recent satellite imagery of the study area delineating the cropping pattern, waste land, forest area and built up area may be prepared.

### Digital Elévation Model (DEM) / Contour map

Contour map at sufficient or acceptable intervals as available in toposheets or as required for the study of project area and site plan of the area showing the various proposed break-up of the land may be prepared.

- Description of the project sites its geology, hydrology, topography, climate, connectivity by road/rail, demographic aspects, socio, cultural and economic aspects, villages, and settlements.
- Details of environmentally sensitive places, land acquisition and rehabilitation of communities/ villages with their present status. The siting criteria delineated by MoEF shall be discussed. Notified restrictions and limitations from environmental considerations etc., if any.
- Historical and climatic data such as climatic conditions, rainfall, wind pattern, history of cyclones, storms surges, visibility etc.,
- Layout plan of proposed project development , activity areas with facilities open to the sky such as runways, taxi/link taxi ways, aprons, drainages, sewage disposal, navigation facilities, communication facilities, airfield lighting, crash fire & rescue facilities, car parking, access/approach roads, refueling facilities, boundary wall, meteorological observatory, landscape, waste disposal etc;
- Layout plan of proposed development of built up areas with covered construction such as terminal buildings and associated facilities, air traffic control tower, Repair& Servicing(R&S) hangars, AC plants, DG set rooms, operational buildings such as RADAR and Instrument Landing System(ILS) structures, administrative buildings, utilities such as main and stand by power, water supply installations, cargo storage facilities, Petrol Oil Lubricant (POL) stores , Aviation Turbine Fuel(ATF) store and Bulk Petroleum installation.;
- In case of expansion/ modernization of the project, the environmental compliance status for the existing project shall be explained. If the potential impact on environment exceed the existing project limits fresh EIA process may be initiated before starting the project.
- Technologies involved for design, construction, equipment and operation are to be detailed.

## 3.0 Analysis of alternatives (Technology & Sites)

If the scoping results in need for alternatives a clear description of the each alternative, summary of the impact - adverse and positive with each site and selection of alternatives is to be detailed out.

## 4.0 Description of the Environment

Environmental data to be considered in relation to airport development would be: (a) land (b) ground water, surface water (c) air (d) biological (e) noise and vibration (f) socio economic and health environment.

### *Study area:*

Primary data by measurements, field surveys and secondary data from secondary sources are to be collected in the study area within 10 km radius from Aero dome Reference Point (ARP). Beyond 10 kms, only secondary data is to be collected. Primary data should cover one season other than monsoon and secondary data for one full year.

Map of the study area clearly delineating the location of various monitoring stations (air, noise, water and soil) superimposed with location of habitats are to be shown. Monitoring should be done as per CPCB guidelines.

## 4.1 Land Environment

### Physiography and Drainage Patterns:

Land farms, terrain, may get affected due to construction of airport. It may require large scale quarrying, dredging and reclamation, which may cause changes in the topography. This in turn may affect the drainage pattern of the land / terrain.

Baseline data to be given on description of existing land area situation at the proposed project area including description of terrain hill slopes terrain features, slope and elevation. Study of land use pattern, habitation, cropping pattern, forest cover, environmental sensitive places etc., by employing remote sensing techniques and ground truthing is to be carried out.

Ecological features of forest area; agricultural land, grazing land, wildlife sanctuary land and national parks, migratory routes of fauna, water bodies, and drainage pattern including the orders of the drain and water sheds are to be shown clearly. Settlements in the study area may be delineated with respect to ARP on the site map. High rise buildings, industrial areas and zones, slaughter houses and other features of flight safety importance may also be marked on the map.

### Soil

Land is one of the important and rare resources. Airport projects require considerable land area for development of activity areas, operational and non- operational buildings, areas for ancillaries, utilities including townships. Sometimes acquisitions of large stretches of land and areas being used by the local habitat may be necessitated requiring rehabilitation measures. Availability of land for earmarking for the airport without causing undue hardship to local habitat and their socio cultural and economic aspects is very important. Site suitability for developing airport is also to be approved by aerodrome standards, directorate in the DGCA, Ministry of Civil Aviation in accordance with Para (xi) of the Aircraft Rules 1937. Baseline data of the land and its availability is to be ascertained from local authorities, revenues records etc., Justification for the proposed quantum of the area to be given.

Soil data including type, classification, characteristics, properties, etc are important from engineering considerations for structures etc. Changes in soil parameters may also affect plantation and vegetation which in turn may endanger the health of habitat.

Baseline data consisting of soil analysis and land use pattern of agriculture lands within the project area is to be collected to assess its fertility. Data pertaining to coverage of land for other purposes and general slope of the terrain within the study area is collected to assess the trends in the land use patterns and the natural runoff patterns.

## 4.2 Water Environment

### Ground water

Baseline data of ground water including data of pH, dissolved solids, suspended solids, BOD, DO, coliform bacteria, oil, fluorides, chlorides, heavy metals etc., to determine the quality of the ground water is to be estimated.

### Surface water

Baseline data on location sources of surface water like water bodies, lakes, their dimensions, present quality and their utility to be provided.

## 4.3 Air Environment

Climatological Data: This is obtained from nearest India Meteorological Department (I M D) station for one full year. Micro meteorological data consisting of wind speed, wind direction, temperature, cloud cover, (amount and height), humidity, rainfall and wind rose, from primary and secondary sources in an area of 10km radius from ARP be obtained, on 24 hr basis.

Ambient Air Quality (AAQ) is important for the airport projects. The significance of aviation's impact on air quality will vary depending on many other factors such as, background pollution levels, other sources of pollution, weather and proximity of residential areas.

Aircraft engines produce emissions that are similar to other emissions resulting from any oil based fuel combustion. These, like any exhaust emissions, can affect local air quality at ground level. It is emissions from aircraft below 1,000ft, above the ground (typically around 3km from departure or, for arrivals, around 6km from touchdown that are chiefly involved in influencing local air quality. These emissions disperse with the wind and blend with emissions from other sources such as domestic heating emissions, factory emissions and transport pollution.

The local air quality relevant emissions attributed to aircraft operations at airports are oxides of nitrogen (NOx), carbon monoxide (CO), Unburnt hydrocarbons (NMHC and VOCs), sulphur dioxide($SO_2$), particulate matter (PM10 and PM2.5).

Aircraft engines, auxiliary power units, apron vehicles, de- icing, and apron spillages of fuel and chemicals emit these pollutants. Local factors influence the significance of individual emissions for each airport, but often NOx is by far the most abundant and is considered the most significant pollutant from an air quality stand point.

Baseline data of these parameters extending over an area of 10km radial distance from ARP of the project by observation at a number of locations, predominantly in the windward direction duly taking into account changes in predominant wind direction in the monsoon period and changes in humidity in atmosphere. Specific importance is to be attached to areas in close proximity of project up to 3km is essential, considering the mobile source of emission such as aircraft.

## 4.4 Noise Environment

Noise pollution is created by airside sources such as aircraft, under their flight paths and also by landside sources such as, DG sets, surface traffic, heavy machinery and aircraft on ground in start-up, taxi, take off and ground run phases. This type of noise during daytime effects the workers' and local population's health in the long run. The existing noise levels before starting the construction of airport are to be measured for collecting baseline data. The process is to be repeated during construction and operational phases of as well.

Measurements should typically be taken as per by CPCB guidelines and recorded as dB(A) in an area of 10km radius from ARP. Hourly equivalent noise levels, Leq, for day and night separately are to be recorded once in each season. Monitoring should typically be conducted with frequency of measurements more along the runways, near residential areas and near ground sources. Locations, at which measurements were taken, should be noted on a base map. Recorded values can be presented in Tables.

## 4.5 Biological Environment

Airport operations may cause change in local ecosystems, threaten endangered species and disturb movements and breeding patterns of local wildlife. Existing biological conditions include the presence and distribution of indigenous and migratory animals, and indigenous plants. Known sensitivities of species of surrogate species should also be stated.

Baseline data on flora and fauna duly authenticated for study area should be furnished, based on field survey clearly indicating the Schedule of the fauna present. Data on sensitive habitats, wild or endangered species in the project area also is collected from Zoological Survey of India (ZSI), Botanical Survey of India (BSI), Wildlife Institute of India (WII) and Ministry of Earth Sciences.

## 4.6 Socio -Economic Environment

Airport development may often require relocation of the local community, sometimes causing ethnic, cultural, tribal or religious conflicts with local people. Industrialization and modernization may change the cultural traditions of the local community. Baseline data on demographics, settlements, infrastructure facilities in the existing and relocated area, economic conditions in the existing and relocated area, cultural and archaeological assets within the project area should be catalogued and plotted on a base map.

## 4.7 Solid Waste

The types of waste, which are generated, can be classified into construction or demolition waste and municipal waste, i.e., biodegradable and recyclable waste, hazardous waste and waste.

Details of authorized Municipal solid waste facilities, biomedical treatment facilities and hazardous waste disposal facilities in the area are to be given.

# 5.0 Anticipated Environmental Impact and Mitigation Measures

## 5.1 Prediction of impact

This should describe the likely impact of the project on each of the environmental parameters, methods adopted for assessing the impact such as model studies, empirical methods, reference to existing similar situations, reference to previous studies, details of mitigation, methods proposed to reduce adverse effects of the project, best environmental practices, conservation of natural resources; environmental management plan; post project environmental monitoring programme including budgeting for the expenditure proposed in the project cost. Reference to the models along with the inputs used may be given.

## 5.2. Land Environment

### Physiography and drainage patterns

*Anticipated Impact:*

Impact of project construction/ operation on the land requirement/ use pattern is to be assessed by standard procedures. Affect of future growth of the airport facility and/ or of the ancillaries is to be carefully assessed by preparing master plans for the airport and the ancillaries. Impact on the public utilities arising out of the project activities and impact on the natural drainage system are equally important. Prediction of impact on the existing infrastructures like road network, housing, loss of productive soil and impact on natural drainage pattern is to be considered. Loss of agriculture land is to be estimated by super posing the project lay-out on the land use site map.

### Mitigation Measures:

Mitigation measures to reduce adverse effects like adopting soil improvement techniques and adopting suitable methods to reduce land requirement are to be identified. Strengthening of road network, infrastructure to handle the increase in traffic, parking arrangements, integration of airport development with the local land use plan are to be considered. Conformance to statutory regulations is to be ensured.

### Soil

#### *Anticipated Impact:*

Impact of airport construction / operation is to be assessed on the topography due to activities like large scale quarrying, filling of low lying areas with dredged spoil and burrowed material. Damage to green belt and plantation, changes in land use patterns, disturbance to existing protected areas like mangroves& forests and environmentally sensitive zones/areas, flooding due to filling up of low lying areas are to be assessed. Study on the trend of change in land use pattern for the last 10 years based on remote sensing data is to be made to establish trends in baseline data. Impact of the project construction / operation on the soil parameters, probability of settlement, subsidence, slides, surface drainage etc.is to be assed.

#### *Mitigation measures:*

Measures for holding storm / flood waters entering project area and construction of drainage lines are to be discussed. Measures for soil erosion at quarry / burrow sites from which soil is drawn for filling, during construction phase to be discussed. Phase wise plan of plantation and compensatory forestation clearly indicating the area to be covered under plantation and the species to be given. Details of the plantation already done to be given. To reduce adverse effects like adopting soil improvement techniques and adopting suitable design methods etc., are to be considered.

## 5.3 Water Environment

#### *Anticipated impact:*

Discharge of trade effluents and sewage, run off from cargo storages and toxic or harmful substances, and their percolation to underground water are to be assessed. Impact of airport operations on surface water sources, contamination due to cargo operations, impact on utility of surface water resources by the neighbouring colonies, impact on surface water flow (flooding) due to any anticipated obstructions and spillages etc. are some of the impact to be mitigated. Detailed water balance along with flow chart of water use for the airports is to be provided.

#### *Mitigation measures:*

Mitigation measures include paving the cargo areas, impervious roads, lined impervious drains; rooting surface drainage to settlement tank/ pits etc.., Protection measures to surface water resources during construction and operational phases along with identification and provision of alternatives for their conservation may be clearly mentioned.

## 5.4. Air Environment:

### *Anticipated impact:*

The impact of project construction / operation on the ambient air quality on account of emissions of dust during construction and emission of gases from airside and land side sources such as aircraft, DG sets, surface traffic etc. in operational phases is to be assessed. Assessment of changes in AAQ parameters by suitable modeling techniques or empirical methods is to be resorted to. Prediction of fugitive dust / air emissions, prediction of point/line source emissions and emissions from the multi volume sources in the airport area is to be done in anticipation of increase in future air and surface traffic.

### *Mitigation measures:*

Mitigation measures to reduce adverse effects during the construction stage and during the operation stage include alternative solutions such as closed conveyor system; lowering the emissions from the automobiles and the aircraft; institutional arrangements proposed with other agencies for effective implementation of environmental measures, applicable for environmental standards and compliance are to be proposed. Landscape development to mitigate the emission levels may be clearly mentioned.

Guidance on mitigation from airside sources, such as the procedures specified in ICAO Circular 303, AN176: and "Operational opportunities to minimize fuel use and emissions"; and the IATA "Guidance Material and Best Practices for Fuel Environmental Management" published Dec.2004 may be referred.

## 5.5 Noise Environment

### *Anticipated impact:*

Impact on the noise environment is due to noise emitted by static and mobile sources from the groundside and airside are to be meduted. Noise pollution by static sources on ground are from aircraft in ground run, taxi mode and DG sets and machinery etc. Noise pollution by mobile sources is from aircraft engines and airframes under its flight path. Suitable modeling techniques may be used for prediction of noise levels.

### *Mitigation Measures:*

Noise pollution can be controlled at the source of generation itself by employing techniques like control in the transmission path; installation barriers etc., Barriers between noise source and receiver can minimize the noise levels. Methods of reduction of noise from the airside sources are stipulated in chapter 3 standards in Annexure 16 of ICAO publication. Noise from DG sets may be reduced by provision of integral acoustic enclosure and by suitably modifying its dimensions. Certain proactive measures adopted in international practice, which act as deterrents for noise generation may be used.

## 5.6 Biological Environment

### *Anticipated Impact:*

Impact of the projects during construction and operational phases, on the biological environment is to be assessed by suitable, empirical model studies. Effect of project on schedule-1 fauna and on fisheries due to displacement of water bodies if any is to be identified in the study area.

*Mitigation measures:*

In case of any Scheduled-1 fauna found in the area, the necessary plan for their conservation should be prepared in consultation with State forest Departments and details furnished. Measures adopted to preserve / relocate the water bodies as sources of irrigation and fisheries in study area be pointed. Phase wise plan of green belt near water bodies be provided. The expenditure may be budgeted in the project cost

## 5.7 Socio-Economic Environment

*Anticipated Impact:*

Impact on the local population, infrastructure facilities, utilities are a to detailed out.

**Mitigation Measures:**

Preservation of cultural, historical and religious sites to honour the sensitivities of the residents may be carried out. Measures of socio- economic benefits proposed to the local communities be provided by the project proponent.

## 5.8 Solid Waste:

*Anticipated Impact:*

Impact of the project construction / operation on generation of waste is to be assessed. Prediction of quantity of solid waste to be generated is waste is to be studied.

*Mitigation measures:*

Minimization of solid waste by using environmentally compatible disposable material; recycling of waste proper management and disposal of temporary structures, made during construction phase is to be done.

## 6.0 Environmental Monitoring Program

This chapter should include:-

- Summary matrix of environmental monitoring, during construction and operation stage of project
- Technical aspects of monitoring for achieving effectiveness in mitigation measures.
- Requirement of monitoring facilities
- Frequency, location, parameters of monitoring
- Compilation and analysis of data and reporting system

## 7.0 Additional Studies

## 7.1 Public consultation

Public hearing with the issues raised by the public and the response of the project proponent in tabular form shall be provided.

## 7.2 Risk Assessment (ERA) and Disaster Management Plan (DMP)

Activities associated with airport construction and operations also give rise to associated hazards and accidents. It is therefore desirable that based on the categories of hazards prevailing at the project site, risk analysis may be carried out by specialists in the field and recommendations may be implemented. Some of the activities requiring attention under this category are

- Occupational hazards due to exposure etc.
- Fire and / or explosion
- Leakage of flammable material
- Release of toxic material

## 7.3 Natural resource conservation

Plan of action for conservation of natural resources and recycling of waste materials due to the project activity in the construction and operational phase of the project is to be discussed for open and covered area constructions. Energy efficiency measures in the activity are to be drawn up.

## 7.4 R&R Action Plan

Detailed R&R plan with data on the existing socio-economic status of the population in the project area and broad plan for resettlement of the displaced population, site for the resettlement colony, alternative livelihood concerns/employment for the displaced people, civil and housing amenities being offered, etc and the schedule of the implementation of the project specific R&R Plan if any is to be given. Details of provisions (capital & recurring) for the project specific R&R Plan.

## 8.0 Project benefits

This section details out the improvements in physical infrastructure, social infrastructure if any. Also it details out any employment potential and other benefits that are accrued if the project is taken up.

## 9.0 Environmental cost benefit analysis

The detailed environmental cost benefit analysis is to be taken up if recommended in the scooping stage of the project.

## 10.0 Environmental Management Plan (EMP)

Summary of potential impact and recommended mitigation measures are to be brought out. Budgeting for the EMP is also to be included in EIA.

- Administrative and technical set up for management of environment
- In built mechanism of self monitoring of compliance of environmental regulations
- Institutional arrangements proposed with other organizations/ Govt. authorities for effective implementation of environmental measures proposed in the EIA
- Safe guards/mechanism to continue the assumptions/field conditions made in the EIA, for arriving the site suitability

Awareness and Training Methodology of training imparted to field personnel may be specified.

Record keeping and reporting: Standard operational/administrative procedures for record maintenance and reporting may be prepared.

## 11.0 Summary & Conclusion (Summary EIA)

The summary should be a clear presentation of the critical facts that make up each issue, and the resolution of the issues. Whenever possible, the summary should make use of base maps, tables and figures. Information should be condensed into succinct, but meaningful presentations. It must be able to stand alone as a document. It should necessarily cover and brief the following chapters of the full EIA report and address the following:-

- Introduction
- Project description & Project benefits
- Environmental Examination
- Additional Studies
- Environmental Management Plan and Post Project Monitoring Program
- Environmental Risk Assessment (ERA) and Disaster Management Plan (DMP)

## 12.0 Disclosure of Consultants Engaged

The team of consultants engaged in this project is to be given.

### Enclosures

Feasibility report/ Duly filled in questionnaire / Relevant figures and tables if referred as annexure in the text/ Photos, or plates of proposed project site, impact areas

# Annexure 2
## Land Use / Land Cover Classification System

| Level -I | Level -II | Level -III |
|---|---|---|
| 1. Built – up land | 1.1. Built –up land | 1.1.1. Urban (towns & cities) |
| 2. Agricultural land | 2.1. Crop land<br>(i) kharif<br>(ii) rabi<br>(iii) double cropped | 2.1.1 Irrigated crop land<br>2.1.2. Unirrigated crop land |
| | 2.2. Fallow | 2.2.1. Fallow |
| | 2.3. Plantation | 2.3.1. Types of plantation, casuarina, coconut, tea etc. |
| 3. Forest | 3.1 evergreen / semi-evergreen | 3.1.1. Dense / closed<br>3.1.2. Open |
| | 3.2. Deciduous | |
| | 3.3. Degraded scrub land | |
| | 3.4. Forest blank | 3.4.1 Degraded forest |
| | 3.4.2. Forest blank | |
| | 3.5. Forest plantation<br>3.6. Mangrove | 3.5.1. Types of plantatin eg. teak, sal etc. |
| 4. Wastelands | 4.1. Salt affected land | |
| | 4.2. Water logged land | |
| | 4.3. Marshy / swampy land | |
| | 4.4. Gullied / ravinous land | |
| | 4.5. Land with or without scrub | |
| | 4.6. Sandy area (coastal & desertic) | Minimum mappable unit IS 2.25 hectares on 1:50,000 scale |
| | 4.7. Barren rocky / stony waste / sheet rock areas | |
| 5. Water bodies<br>5.2 | 5.1. River / stream<br>Lake / reservoir / tank / canal | |
| 6. Others | 6.1. Shifting cultivation | 6.1.1. Current |
| 6.1.2. | Old / abandoned | |
| 6.2. | grassland / grazing land | 6.2.1. Grassland / grazing land |
| 6.3. | Snow covered / glacial area | 6.3.1. Snow covered / glacial area |
| 6.4. | Mining area | 6.4.1. Mining dumps |

**Note:** Land use / Land cover categories at different levels and corresponding scales for mapping are as follows:

| | | | | |
|---|---|---|---|---|
| Level – I | – | categories | – | 1:1000,000 scale |
| Level – II | – | categories | – | 1:250,000 scale |
| Level – III | – | categories | – | 1:50,000 scale and 1:25,000 scale |

*(Sources: Description and classification of land use / land cover : NRSA – TR – LU & CD – 01 –90)*

# Annexure 3
## Sampling, Frequency & Method of Baseline Environment Monitoring

| Attributes | Sampling | | Measurement Method | Remarks |
|---|---|---|---|---|
| A. Air Environment | Network | Frequency | | |
| Meteorological<br>• Wind speed<br>• Wind direction<br>• Maximum temperature<br>• Minimum temperature<br>• Relative humidity<br>• Rainfall<br>• Solar radiation<br>• Cloud cover<br>• Environmental Lapse Rate | 1 site in the project area | 1 hourly continuous | Mechanical/automatic weather station<br><br>Max/Min Thermometer<br>Hygrometer<br><br>Rain gauge<br>As per IMD specifications<br>As per IMD specifications<br><br>Mini Sonde/SODAR | IS 5182 Part 1-20<br>Site specific primary data is essential<br><br>Secondary data from IMD<br><br>CPCB guidelines |
| Pollutants<br>• PM (10)<br><br>• PM (2.5)<br><br>• $SO_2$<br><br>• $NO_x$<br><br>• Lead in PM | Nos. of sampling location to be decided | 24 hourly twice a week<br><br>@4 hourly. Twice a week, One non monsoon season<br>8 hourly, twice a week<br><br>24 hourly, twice a week | As per CPCB guidelines | Monitoring Network<br>• Minimum one locations in upwind side, two sites in downwind side / impact zone<br>• All the sensitive receptors need to be covered for core zone and buffer zone |

| Attributes | Sampling | | Measurement method | Remarks |
|---|---|---|---|---|
| B. Noise | Network | Frequency | | |
| • Hourly equivalent noise levels | Identified study area | Once in season | Noise level meter | IS:4954-1968 as adopted by CPCB |
| • Peak particle velocity | 150-200m from blast site | Once | PPV meter | |
| C. Water | | | | |
| Parameters for water quality<br>• pH, temperature, turbidity, magnesium hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium, salinity<br>• Total nitrogen, total phosphorus, DO, BOD, COD<br>• Heavy metals<br>• Total coliforms, faecal coliforms<br>• Phyto plankton | • Set of grab samples for ground and surface water | | Samples for water quality should be collected and analysed as per :<br>• IS : 2488 (Part 1-5) methods for sampling and testing of Industrial effluents<br>• Standard methods for examination of water and wastewater analysis published by American Public Health Association. | |
| D. Land environment | | | | |
| Soil<br>• Organic Matter<br>• Texture<br>• pH<br>• Electrical conductivity<br>• Permeability<br>• Water holding capacity<br>• Porosity | Sample from villages (soil samples be collected as per BIS specifications) | One season | Collected and analysed as per soil analysis reference | Analysis be done as per BIS specifications |

# Annexure 4.1

## Criteria for Raw Water Used for Organized Community Water Supplies (Surface and Ground Water)

## Primary Parameters

| | Parameters | Range/Limiting Value | | Note |
|---|---|---|---|---|
| | | Use with only disinfection | Use after conventional treatment | |
| 1. | pH | 6.5 to 8.5 | 6.0 to 9.0 | To ensure prevention of corrosion in treatment plant and distribution system and interference in coagulation and chlorinating. |
| 2. | Colour Pt. scale Hz Units | < 10 | < 50 | Color may not get totally removed during treatment |
| 3. | Suspended Solids mg/l | < 10 | < 50 | High SS may increase the cost of treatment. |
| 4. | Odour, dilution factor | < 3 | < 10 | May not be tackled during treatment. |
| 5. | DO, (%saturation) | 90-100 | 80-120 | May imply higher chlorine demand. |
| 6. | BOD, mg/l | < 3 | < 5 | Same as above. |
| 7. | TKN, mg/l | < 1 | < 3 | Same as above. |
| 8. | Ammonia, mg/l | < 0.05 | < 1 | Same as above. |
| 9. | Faecal coliform MPN/100 ml | < 200 | < 2000 | Not more than 20% samples show greater than limit. |
| 10. | EC, µm/hos/cm | < 2000 | < 2000 | High conductivity implies dissolved high solids making water unpalatable. |
| 11. | Chloride, mg/l | < 300 | < 300 | May cause physiological impact and unpalatable taste. |
| 12. | Sulphates, mg/l | < 250 | <250 | May cause digestive problems |
| 13. | Phosphates, mg/l | < 0.7 | < 1.0 | May interfere with coagulation |
| 14. | Nitrate, mg/l | < 50 | < 50 | May cause methamoplobinemea |
| 15. | Fluoride, mg/l | < 1.0 | < 1.5 | Higher value shall cause fluorosis and lower value shall carries. |
| 16. | Surfactants, mg/l | < 0.2 | < 0.2 | May impair treatability and cause foaming. |

Additional Parameters for Periodic Monitoring (Seasonal - Only to be done when there are known natural or anthropogenic sources in the upstream catchment region likely or apprehended to contribute or other well founded apprehensions)

| Parameters | Desirable | Acceptable | Note |
|---|---|---|---|
| Dissolved Iron mg/l | < 0.3 | < 0.5 | Affect taste and cause stains |
| Copper, mg/l | -- | < 1.0 | May cause live damage |
| Zinc, mg/l | -- | < 5.0 | Cause bitter stringent taste |
| Arsenic, mg/l | < 0.01 | < 0.05 | Cause hyperkeratosis & skin cancer |
| Cadmium, mg/l | < 0.001 | < 0.005 | Toxic |
| Total Chromium, mg/l | < 0.05 | < 0.05 | Toxic |
| Lead, mg/l | < 0.05 | < 0.05 | Physiological abnormality |
| Selenium, mg/l | < 0.01 | < 0.01 | Toxic symptoms similar to arsenic |
| Mercury, mg/l | < 0.005 | <0.0005 | Carcinogenic and poisonous |
| Phenols, mg/l | < 0.001 | < 0.001 | Toxic and cause taste and odour problem |
| Cyanides, mg/l | < 0.05 | < 0.05 | Physiological abnormality |
| PAH, mg/l | < 0.0002 | < 0.0002 | Carcinogenic |
| Total Pesticides, mg/l | < 0.001 | < 0.0025 | Trend to bioaccumulates & carcinogenic |

*(Source: Ecological Impact Assessment Series: EIAS/03/2002-03 Published by CPCB)*

## Annexure 4.2

## Use Based Classification of Surface Waters in India

| Designated-Best-Use | Class of water | Criteria |
|---|---|---|
| Drinking Water Source without conventional treatment but after disinfection | A | 1. Total Coliforms OrganismMPN/100ml shall be 50 or less<br>2. pH between 6.5 and 8.5<br>3. Dissolved Oxygen 6mg/l or more<br>4. Biochemical Oxygen Demand 5 days 20°C 2mg/l or less |
| Outdoor bathing (Organized) | B | 1. Total Coliforms Organism MPN/100ml shall be 500 or less<br>2. pH between 6.5 and 8.5<br>3. Dissolved Oxygen 5mg/l or more<br>4. Biochemical Oxygen Demand 5 days 20°C 3mg/l or less |
| Drinking water source after conventional treatment and disinfection | C | 1. Total Coliforms Organism MPN/100ml shall be 5000 or less<br>2. pH between 6 to 9<br>3. Dissolved Oxygen 4mg/l or more<br>4. Biochemical Oxygen Demand 5 days 20°C 3mg/l or less |
| Propagation of Wild life and Fisheries | D | 1. pH between 6.5 to 8.5<br>2. Dissolved Oxygen 4mg/l or more<br>3. Free Ammonia (as N) 1.2 mg/l or less |
| Irrigation, Industrial Cooling, Controlled Waste disposal | E | 1. pH between 6.0 to 8.5<br>2. Electrical Conductivity at 25oC micro mhos/cm Max.2250<br>3. Sodium absorption Ratio Max. 26<br>4. Boron Max. 2mg/l |

*(Source: Guidelines for Water Quality Management -CPCB 2008)*

## Annexure 5.1

## Aircraft Emission Standards for Subsonic Engines Manufactured on or after 01-01-1983. (Ref: ICAO Annex 16 Vol-II PartIII, Chapt-2)

| | (Sub sonic engines) before 01-01 - 1983 | (ICAO Annex 16, Vol II Part III, Chap 2) |
|---|---|---|
| Serial Number | Parameter | Values |
| 1 | Hydrocarbons (HC) gm/KN | $Dp/F\infty = 19.6$ |
| 2 | Carbon Monoxide (CO) gm/KW | $Dp/F\infty = 118$ |
| 3 | Oxides of Nitrogen ($NO_x$) gm/KN | $Dp/F\infty = 40+2\pi\infty, 32+1.6\pi\infty$<br>HC - Total Hydrocarbon compounds of all classes and molecular wax hts contained in a gas sample,calculated as if they were in the form Methane.<br><br>$NO_x$ - The sum of the amounts of Nitric Oxide and Nitrogen dioxide contained in a gas sample as if Nitric odixe were in the form of Nitrogen dioxide |
| 4 | Smoke Number (SN) | $83.6 (F\infty)^{-0.274}$ or 50 which ever is lower |

. as if the nitric oxide is in the form nitrogen dioxide

SN - The dimensionless term quantifying smoke emissions.

Dp - Mass (in gms) of gaseous pollutants (HC, CO, NOx) emitted during the reference emissions (LO) Cycle.

$F\infty$ - Rated output of the engine (in kilo newtons) in Max Thrust available for take-off under normal operating conditions at ISA sea level static conditions without use of water injections as certified.

- Pressure ratio i.e. ratio of Mean Total pressure at the last compressor discharge plan of the compressor to the mean total pressure at the compressor entry plane when the engine is developing take off thrust rating in ISA Sea Level static conditions (to which all engine performance should be corrected).

## Annexure 5.2

## Time and Thrust Setting for Reference L to (Landing, Take Off) Cycle

| Phase | Time in Operating Mode (Mts) | Thrust Setting |
|---|---|---|
| Take Off | 0.7 | 100% F |
| Climb | 2.2 | 85% F |
| Approach | 4.0 | 30% F |
| Taxi/Ground idle | 26.0 | 7% F |

## Annexure 5.3
## Emissions From Large/Medium/Small Aircrafts

| Parameter | Units | Value | | |
|---|---|---|---|---|
| Type of aircraft | - | B 747 - 400 (Large) | B767 - 400 (Medium) | A 330 - 300 (Small) |
| Engine Type | - | CF6-80C2B5F | CF6-80C2 | CF6-80 EI |
| No of Engines | - | 4 | 4 | 2 |
| Rated output F | | | | |
| Max Thrust | | | | |
| | Kilo Newton | 276 | 283 | 320 |
| Smoke Number | - | 17.9 | 17.8 | 17.2 |
| TOTAL EMISSIONS (gm/Sec) | | | | |
| Dp (HC) | gm/Sec | 170.6 | 175.0 | 197.8 |
| Dp )CO) | gm/Sec | 1027.3 | 1053.4 | 1191.1 |
| Dp (Nox) | Gm/Sec | 609.4 | 624.9 | 706.6 |

Source: Emission Data Calculation based on ICAO Standard
( Ref: ICAO Annexure 16,Volume II part III, Chapter-2 )

## Annexure 5.4
## National Ambient Air Quality Standards

| S. No | Pollutants | Time Weighted Average | Concentration in Ambient Air | | |
|---|---|---|---|---|---|
| | | | Industrial, Residential, Rural and Other Areas | Ecologically Sensitive Area (notified by Central Government) | Methods of Measurement |
| 1. | 2. | 3. | 4. | 5. | 6. |
| 1 | Sulphur Dioxide ($SO_2$), µg/m³ | Annual* | 50 | 20 | Improved west & Gaeke |
| | | 24 hours** | 80 | 80 | Ultraviolet fluorescence |
| 2 | Nitrogen Dioxide ($NO_x$), µg/m³ | Annual* | 40 | 30 | - Modified Jacob & Hochhieser (Na - Arsenite)<br>- Chemiluminescence |
| | | 24 hours** | 80 | 80 | |
| 3 | Particulate Matter (size less than 10 µm) or $PM_{10}$, µg/m³ | Annual* | 60 | 60 | - Gravimetric<br>- TOEM<br>- Beta Attenuation |
| | | 24 hours** | 100 | 100 | |
| 4 | Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$, µg/m³ | Annual* | 40 | 40 | - Gravimetric<br>- TOEM<br>- Beta Attenuation |
| | | 24 hours** | 60 | 60 | |
| 5 | Ozone ($O_3$), µg/m³ | 8 hours** | 100 | 100 | - UV Photometric<br>- Chemiluminescence<br>- Chemical method |

| | | | | | |
|---|---|---|---|---|---|
| 6 | Lead (Pb), µg/m$^3$ | Annual* | 0.50 | 0.50 | - AAS/ICP method after sampling on EPM 2000 or equivalent filter paper<br>- ED-XRF using Teflon filter |
| | | 24 hours** | 1.0 | 1.0 | |
| 7 | Carbon Monoxide (CO), mg/m$^3$ | 8 hours** | 02 | 02 | - Non-Dispersive Infra Red (NDIR) Spectroscopy |
| | | 1 hour** | 04 | 04 | |
| 8 | Ammonia ($NH_3$), µg/m$^3$ | Annual* | 100 | 100 | - Chemiluminescence<br>- Indophenol blue method |
| | | 24 hours** | 400 | 400 | |
| 9 | Benzene ($C_6H_6$), µg/m$^3$ | Annual* | 05 | 05 | - Gas Chromatography based continuous analyzer<br>- Adsorption and Desorption followed by GC analysis |
| 10 | Benzo(O)Pyrene (BaP) – Particulate phae only, ng/m$^3$ | Annual* | 01 | 01 | - solvent extraction followed by HPLC/GC analysis |
| 11 | Arsenic (As), ng/m$^3$ | Annual* | 06 | 06 | - AAS/ICP method after sampling on EPM 2000 or equivalent filter paper |
| 12 | Nickel (Ni), ng/m$^3$ | Annual* | 20 | 20 | - AAS/ICP method after sampling on EPM 2000 or equivalent filter paper |

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

**Note:** Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limit specified above for the respective category, it shall be considered adequate reason to institute regular/continuous monitoring and further investigations.

*(Source: As notified by CPCB in the Gazette vide No. b- 29016/20/90/PCI-I, dated. 18th November, 2009)*

# Annexure 6
## Ambient Air Quality Standards in Respect of Noise

| Area code | Category of area | Limits in db (A) Leq | |
|---|---|---|---|
| | | Day time | Night time |
| A | Industrial area | 75 | 70 |
| B | Commercial area | 65 | 55 |
| C | Residential area | 55 | 45 |
| D | Silence zone | 50 | 40 |

**Note:**

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area, which is declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

* dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A "decibel" is a unit in which noise is measured.

"A", in dB(A) $L_{eq}$, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

$L_{eq}$: It is an energy mean of the noise level over a specified period.

*(Source: Noise pollution (Regulation and control) Rules, 2000)*

# Annexure 7
# List of Critically Polluted Industrial Cluster/Area Identified by CPCB

| S. No. | Critically Polluted Industrial Area and CEPI | Industrial Clusters/Potential Impact Zones |
|---|---|---|
| 1 | Ankleshwar (Gujarat) *CEPI-88.50* (*Ac_Wc_Lc*) | GIDC Ankleshwar and GIDC, Panoli |
| 2 | Vapi (Gujarat) *CEPI-88.09 (Ac_Wc_Lc)* | GIDC Vapi |
| 3 | Ghaziabad (Uttar Pardesh) *CEPI-87.37* (*Ac_Wc_Lc*) | **Sub-cluster A**<br>• Mohan nagar Industrial area<br>• Rajinder nagar Industrial area<br>• Sahibabad Industrial area<br>**Sub-cluster B**<br>• Pandav nagar Industrial area<br>• Kavi nagar Industrial area<br>• Bulandshahar Road Industrial area<br>• Amrit nagar<br>• Aryanagar Industrial area<br>**Sub-cluster C**<br>• Merrut road Industrial area<br>**Sub-cluster D**<br>• Loni Industrial area<br>• Loni Road Industrial area<br>• Roop Nagar Industrial area<br>**Sub-cluster E**<br>• Hapur Road Industrial area<br>• Dasna<br>• Phikua<br>**Sub-cluster F** (other scattered Industrial areas)<br>• South side of GT road<br>• Kavi Nagar<br>• Tronica city<br>• Anand Nagar<br>• Jindal Nagar<br>• Prakash Nagar<br>• Rural Industrial estate |
| 4 | Chandrapur (Maharashtra) *CEPI-83.88* (*Ac_Wc_Lc*) | Chandrapur (MIDC Chandrapur, Tadali, Ghuggus, Ballapur) |
| 5 | Korba (Chhatisgarh) *CEPI-83.00* (*Ac_Ws_Lc*) | a) Industrial areas and their townships of NTPC, BALCO, CSEB (East) & CSEB (West)<br>b) Korba town |
| 6 | Bhiwadi (Rajassthan)<br>*CEPI-82.91* (*Ac_Wc_Ls*) | a) RIICO Industrial areas Phase I to IV<br>b) Bhiwadi town<br>c) Other surrounding industrial areas: Chopanki, Rampura Mundana, Khuskhera Phase I to III. |
| 7 | Angul Talcher (Orissa)<br>*CEPI-82.09* (*Ac_Wc_Lc*) | a) MCL Coal Mining Area, Angul – Talcher region<br>b) Industrial Area (60 km x 45 km)<br>Following blocks of Angul District:<br>- Kohina block<br>- Talcher block<br>- Angul block<br>- Chhendipada block<br>- Banarpal block<br>And<br>Odapada block of Dhenkamal District |
| 8 | Vellore (North Arcot) (Tamilnadu)<br>*CEPI-81.79 (Ac_Wc_Lc)* | Ranipet, SIPCOST Industrial Complex |
| 9 | Singurauli (Uttar Pradesh)<br>*CEPI-81.73* (*Ac_Wc_Ls*) | Sonebhadra (UP)<br>• Dala-Tola<br>• Obra<br>• Renukoot<br>• Anpara<br>• Renusagar<br>• Kakri<br>• Dudhichuwa<br>• Bina<br>• Khadia<br>• Shakti Nagar<br>• Rihand Nagar<br>• Bijpur<br>Sigrauli (Madhya Pradesh)<br>Vindhyachal Nagar and Jayant, Nigahi, Dudhichua, Amlohri & Jhingurdah townships |

| S. No. | Critically Polluted Industrial Area and CEPI | Industrial Clusters/Potential Impact Zones |
|---|---|---|
| 10 | Ludhiana (Punjab)<br>*CEPI-81.66* (*Ac_Wc_Ls*) | Ludhiana Muncipal limits covering industrial clusters:<br>• Focal Point Along with NH_I_Tota Eight Phase<br>• Industrial Area-B-From Sherpur chowk to Gill road & Gill road to Miller Kotla road (left Side of Road)<br>• Mixed Industrail Area – Right side of Gill road<br>• Industrial area – C (near Jugiana Village)<br>• Industrial Area A & Extension: Area between old GT Road and Ludhiana by pass road<br>• Industrial Estate : Near Dholwal chowk<br>• Mixes Industrial Area (MIA) Miller gunj<br>• MIA-By pass road<br>• Bahdur Industrial Area<br>• Tejpur industrial Complex. |
| 11 | Nazafgarh drain basin, Delhi<br>*CEPI-79.54* (*As_Wc_Lc*) | Industrial areas : Anand Parvat, Naraina, Okhla and Wazirpur |
| 12 | NOIDA (Uttar Pradesh)<br>*CEPI-78.90* (*Ac_Wc_Lc*) | Territorial jurisdiction of :<br>• Noida Phase - 1<br>• Noida Phase - 2<br>• Noida Phase – 3<br>• Surajpur Industrial Area<br>• Greater Noida Industsrial Area<br>• Village-Chhaparaula |
| 13 | Dhanbad (Jharkhand)<br>*CEPI-78.63* (*Ac_Ws_Lc*) | Four blocks of Dhanbad district:<br>• Sadar (Dhanbad Municipality)<br>• Jharia (Jharia Municipality, Sindri Industrial Area)<br>• Govindpur (Govindpur Industrial Estate)<br>• Nirsa |
| 14 | Dombivalli (Maharashtra)<br>*CEPI-78.41*(*Ac_Wc_Ls*) | MIDC Phase-I, Phase-II |
| 15 | Kanpur (UttarPradesh)<br>*CEPI-78.09* (*Ac_Wc_Ls*) | • Industrial areas:<br>• Dada Nagar<br>• Panki<br>• Fazalganj<br>• Vijay Nagar<br>• Jajmau |
| 16 | Cuddalore (Tamilnadu)<br>*CEPI-77.45* (*As_Wc_Lc*) | SIPCOT Industrial Complex, Phase I & II |
| 17 | Aurangabad (Maharashtra)<br>*CEPI-77.44* (*Ac_Wc_Ls*) | MIDC Chikhalthana, midc Waluj, MIDC Shendra, and Paithan Road industrial area |
| 18 | Faridabad (Haryana)<br>*CEPI-77.07* (*Ac_Ws_Lc*) | • Sector 27 - A, B, C, D<br>• DLF Phase – 1, Sector 31, 32<br>• DLF Phase – 2, Sector 35<br>• Sector 4, 6, 24, 25, 27, 31, 59<br>• Industrial area Hatin<br>• Industrial Model town Ship |
| 19 | Agra (Uttar Pradesh)<br>*CEPI-76.48* (*As_Wc_Ls*) | Nunihai Industraial Estate, Rambag Nagar,<br>UPSIDC Industrial Area, and Runukata Industrial Area |
| 20 | Manali (Tamilnadu)<br>*CEPI-76.32* (*Ac_Ws_Ls*) | Manali Industrial Area |
| 21<br><br><br>22 | Haldia (West Bengal)<br>*CEPI-75.43* (*As_Wc_Ls*)<br><br>Ahmedabad (Gujarat)<br>*CEPI-75.28* (*Ac_Ws_Ls*) | 5 km wide Strip (17.4 x 5.0 km) of industrial area on the southern side of the confluence point of Rivers Hugli and Rupnarayan, covering Haldia Municipa Area & Sutahata Block-I and II<br>• GIDC Odhav<br>• GIDC Naroda |
| 23 | Jodhpur (Rajasthan)<br>*CEPI-75.19 (As_Wc_Ls*) | • Industrial areas including Basni Areas (Phase-I & II), Industrial Estate, Light & Heavy industrial areas, industrial areas behind new Power House, Mandore, Bornada, Sangariya and Village Tanwda & Salawas.<br>• Jodhpur city |
| 24 | Greater Coach (Kerala)<br>*CEPI-75.08* (*As_Wc_Ls*) | Eloor-Edayar Industrail Belt,<br>Ambala Mogal Industrial areas |
| 25 | Mandi Gobind Garh (Punjab) *CEPI-75.08* (*Ac_Ws_Lc*) | Mandi Govindgarh municipal limit and Khanna area |
| 26 | Howrah (West Bengal)<br>*CEPI-74.84* (*As_Ws_Lc*) | a) Liluah-Bamangachhi Region, Howrah<br>b) Jalah Industrial Complex-1, Howrah |
| 27 | Vatva (Gujarat)<br>*CEPI-74.77* (*Ac_Wc_Ls*) | GIDC Vatva, Narol Industrial Area<br>(Villages Piplaj, Shahwadi, Narol) |

| S. No. | Critically Polluted Industrial Area and CEPI | Industrial Clusters/Potential Impact Zones |
|---|---|---|
| 28 | Ib Valley (Orissa)<br>*CEPI-74.00* (*Ac_Ws_Ls*) | Ib Valley of Jharsuguda (Industrial and Mining area) |
| 29 | Varansi-Mirzapur (Uttar Pradesh)<br>*CEPI-73.79* (*As_Wc_Ls*) | • Industrial Estate, Mirzapur<br>• Chunar<br>• Industrial Estate, Chandpur Varanasi<br>• UPSIC, Industrial Estate, Phoolpur<br>• Industrial Area, Ramnagar, Chandaull |
| 30 | Navi Mumbai (Maharashtra)<br>*CEPI-73.77* (*Ac_Ws_Ls*) | TTC Industrial Area, MIDC, Navi Mumbai<br>(including Blocks-D, C, EL, A, R, General, Kalva) |
| 31 | Pali (Rajasthan)<br>*CEPI-73.73* (*As_Wc_Ls*) | a) Existing industrial areas: Mandia Road, Puniyata Road, Sumerpur<br>b) Pali town |
| 32 | Mangalore (Karnataka)<br>*CEPI-73.68* (*Ac_Ws_Ls*) | Baikampady Industrial Area |
| 33 | Jharsuguda (Orissa)<br>*CEPI-73.34* (*Ac_Ws_Ls*) | Ib Valley of Jharsuguda (Industrial and Mining area) |
| 34 | Coimbatore (Tamil Nadu)<br>*CEPI-72.38* (*Ac_Ws_Ln*) | SIDCO, Kurichi Industrial Clusters |
| 35 | Bhadravati (Karnataka)<br>*CEPI-72.33* (*Ac_Ws_Ln*) | KSSIDC Industrial Area<br>Mysore Paper Mill & VISL Township Complex |
| 36 | Tarapur (Maharashtra)<br>*CEPI-72.01* (*Ac_Ws_Ls*) | MIDC Tarapur |
| 37 | Panipat (Haryana)<br>*CEPI-71.91* (*As_Ws_sc*) | Panipat Municipal limit and its industrial clusters |
| 38 | Indore (Madhya Pradesh)<br>*CEPI-71.26* (*As_Ws_Ls*) | Following 09 industrial areas:<br>• Sanwer Road<br>• Shivaji Nagar<br>• Pologround<br>• Laxmibai Nagar<br>• Scheme No. 71<br>• Naviakha,<br>• Pipliya<br>• Palda<br>• Rau<br>• Indore city<br>• Other surrounding industrial areas : Manglia, Rajoda, Barlal, Asrawad, Tejpur Gadwadi |
| 39 | Bhavnagar (Gujarat)<br>*CEPI-70.99* (*As_Ws_Ls*) | GIDC Chitra, Bhavnagar |
| 40 | Vishakhapatnam (Andhra Pradesh)<br>*CEPI-70.82* (*As_Ws_Ls*) | Bowl area<br>(the area between Yarada hill range in the south to Simhachalam hill range in the north and sea on the east and the present NH-5 in the West direcdtion) |
| 41 | Junagarh (Gujarat)<br>*CEPI-70.82* (*As_Ws_Ls*) | Industrial Areas:<br>• Sabalpur<br>• Jay Bhavani<br>• Jay Bhuvneshwari<br>• GIDC Junagarh (I&II) |
| 42 | Asansole (West Bengal)<br>*CEPI-70.20* (*As_Ws_Ls*) | Burnpur area surrounding IISCO |
| 43 | Patancheru- -Bollaram<br>(Andhra Pradesh)<br>*CEPI-70.07* (*As_Ws_Ls*) | Industrial Area:<br>• Patancheru<br>• Bollaram |

**Note:** Names of identified industrial clusters/ potential impact zones are approximate location based on rapid survey and assessment and may alter partially subject to the detailed field study and monitoring. Detailed mapping will be made available showing spatial boundaries of the identified industrial clusters including zone of influence/buffer zone, after in depth field study.

Aggregated Comprehensive Environmental Pollution Index (CEPI) scores of 70 and above are considered as critically polluted industrial clusters/ areas.

Source: Ecological Impact Assessment Series: EIAS/5/2009-10
Details of Critically Polluted Industrial Areas and Clusters/ Potential Impact Zone in terms of the Office Memorandum no. J-11013/5/2010-IA.II(I) dated 13.1.2010

# Annexure 8

## Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework Used for Impact Prediction: Risk Assessment

| **Relevance** | | |
|---|---|---|
| **Name** | **Application** | **Remarks** |
| EFFECT<br><br>WHAZAN | • Consequence Analysis for Visualisation of accidental chemical release scenarios & its consequence<br>• Consequence Analysis for Visualisation of accidental chemical release scenarios & its consequence | Heat load, pressure wave & toxic release exposure neutral gas dispersion |
| HEGADIS | • Consequence Analysis for Visualisation of accidental chemical release scenarios & its consequence | Dense gas dispersion |
| HAZOP and Fault Tree Assessment | • For estimating top event probability | Failure frequency data is required |
| Pathway reliability and protective system hazard analysis | • For estimating reliability of equipment and protective systems | Markov models |
| Vulnerability Exposure models | • Estimation of population exposure | Uses probit equation for population exposure |
| F-X and F-N curves | • Individual / Societal risks | Graphical Representation |

## Annexure 9.1

## Damage Due To Incident Radiation Intensity (World Bank Standards)

| Sl No | Incident - Radiation ($KW/m^2$) | Type of Damage Intensity<br>Damage to Equipment | Damage to People |
|---|---|---|---|
| 1 | 37.5 | Damage to process Eqpt | 100% Lethality in 1 min. |
| 2 | 25 | Minimum energy required to ignite wood at indefinitely long exposure without a flame | 50% lethality in 1 min. Significant injury in 10 sec. |
| 3 | 19 | Max. Thermal Radiation intensity allowed on thermally unprotected adjoining equipment | - |
| 4 | 12.5 | Minimum energy to ignite with a flame, melts plastic tubing | 1% lethality in 1 min |
| 5 | 4.5 | - | Causes pain if more than 20 secs Blistering is unlikely |
| 6 | 1.6 | | Causes no discomfort on long exposures |

## Annexure 9.2

## Radiation Exposure And Lethality

| Radiation Intensity ($KW/m^2$) | Exposure Time (Seconds) | Lethality (%) | Degree of Burns |
|---|---|---|---|
| 1/6 | - | 0 | No Discomfort even after Long exposure |
| 4.5 | 20 | 0 | 1st |
| 4.5 | 50 | 0 | 1st |
| 8.0 | 20 | 0 | 1st |
| 8.0 | 50 | <1 | 3rd |
| 8.0 | 60 | <1 | 3rd |
| 12.0 | 20 | <1 | 2nd |
| 12.0 | 50 | 8 | 3rd |
| 12.5 | - | 1 | - |
| 25.0 | - | 50 | - |
| 37.5 | - | 100 | - |

Source: http://europe.osha.eu.int/good_practice/risks/ds/oel accessed December 2008

# QUESTIONNAIRE

# QUESTIONNAIRE FOR
# ENVIRONMENTAL APPRAISAL FOR AIRPORTS

**Note 1:** All information to be given in the form of Annexures should be properly numbered and form part o this proforma.

**Note 2:** No abbreviations to be used - Not available or not applicable should be clearly mentioned.

## I. General Information

### 1.1 Name of the project :

(b) Name of the authorized signatory :

(c) Mailing Address :

E-mail :

Telephone :

Fax No. :

(c) Does the proposal relate to new project/ expansion/modernization :

### 1.2 Site Information

(a) Location of Airport:

| Village(s) | Tehsil | District | State |
|---|---|---|---|
| | | | |

(b) Geographical information

- Latitude :
- Longitude :
- Total area envisaged for setting up of project (in ha) :
- Nature of terrain (hilly, valley, plains, coastal plains etc) :
- Nature of soil (sandy, clayey, sandy loam etc) :
- Seismic zone classification :
- Does the site falls under CRZ classification? :
- Land usage of the proposed project site :

## Geographical Information of Aerodrome Reference Point: (ARP)

- Latitude :
- Longitude :
- G.T. Sheet No. (Survey of India Map No. :
- Elevation above Mean Sea level (metres) :
- Total Area proposed for the Project (in ha) :
- Nature of Terrain :
- Nature of Soil (Clayey, Sandy, salty, loam etc.,) :
- Permeability :

### 1.3. Environmental sensitivity details within 10 km from the boundary of the project for applicability of "General Condition (GC)" as per EIA notification dated 14.9.2006 and amendments as on date

| S.No | Item | Name | Aerial Disance (in Km) |
|---|---|---|---|
| 1. | Protected areas notified under the wild life (Protection) Act, 1972 | | |
| 2. | Critically polluted areas as identified by the CPCB | | |
| 3. | Eco-sensitive areas as notified under Section 3 of the E (P) Act 1986 | | |
| 4. | Inter-state boundaries and international boundaries | | |

## 1.4. Environmental sensitivity areas as mentioned at column 9(III) of EIA Notification 2006

| S.No | Areas | Name/ Identify | Aerial distance (within 15 km) Proposed project location boundary |
|---|---|---|---|
| 1 | Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value | | |
| 2 | Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests | | |
| 3 | Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, resting, migration etc | | |
| 4 | Inland, coastal, marine or underground waters | | |
| 5 | State, National boundaries | | |
| 6 | Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas | | |
| 7 | Defense installations | | |
| 8 | Densely populated for built-up area | | |
| 9 | Areas occupied by sensitive man-made land uses *(hospitals, schools, places of worship, community facilities)* | | |
| 10 | Areas containing important, high quality or scarce resources *(ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)* | | |
| 11 | Areas already subjected to pollution or environmental damage *(those where existing legal environmental standards are exceeded)* | | |
| 12 | Areas susceptible to natural hazard which could cause the project to present environmental problems (earthquakes, subsidence, land slides, erosion, flooding or extreme or adverse climatic conditions) | | |

*** 0.5 km from Railway lines/National / State Highway should be maintained**

### Description of the flora/vegetation in the project area

### Description of fauna (non-domesticated) in the project area

## 1.5. Baseline data

### *Meteorological data*

| |
|---|
| |

### *Ambient air quality data*

| |
|---|
| |

### *Water quality data*

| |
|---|
| |

### *Human Settlement*

| | With in the project site | With in 1 km from the project boundary |
|---|---|---|
| Population* | | |
| No. of villages | | |
| Number of households village-wise | | |

## 1.6. Current land use of the proposed project site Area(in ha) :

| Level -I |
|---|
| 1. Built - up land |
| 2. Agricultural land |
| 3. Forest |
| 4. Wastelands |
| 5. Water bodies |
| 6. Others |
| Total |

## 2. Any application made for the Aeronautical clearance from Aerodrome Standards Directorate of DGCA; Ministry of Civil Aviation, GOI.

Yes ☐ No ☐

**if YES, what is the progress?**

## 3. Land use plan:

3.1 Does the proposed project conform to the approved land use all over the site? (To be certified by the concerned Department of State Government).

Yes ☐ No ☐

If not, clearly indicate which of the stretches are not as per approved land use.

3.2 Project Site Preparation:

Is the proposed project located in low- lying area?

Yes ☐ No ☐

Level before filling (above MSL in m) ☐

Level after filling (above MSL in m) ☐

Details of fill material required: ☐

Quantity of Fill material required (in cu.m) ///

Source ☐

Gradient Details: ☐

3.3 Would the above filling result in complete / partial filling of water bodies ☐

3.4 Does the site involve stripping?

Yes ☐ No ☐

If yes, provide the following details:

1. Size of the area to be stripped ☐
2. Location, ☐

3. Soil Type,

4. Volume and quantity of earth to be removed,

5. Location of dump site,

6. Proposal for utilisation of removed topsoil.

3.5. Does it involve cutting?

Yes ☐ No ☐

If yes , please furnish the following details:

1. Size of the area to be cut,

2. Depth of cut,

3. Location,

4. Soil Type,

5. Volume and quantity of earth and other material to be removed

6. Location of dump site.

3.6. Does the site preparation require cutting of trees?

Yes ☐ No ☐

If yes, please furnish the following details:

1. How many trees are proposed to be cut?

2. Species of the above trees

3. Are there any protected / endangered species?

Yes ☐ No ☐

If yes, please provide details.

3.7 In case the site covers a flood plain of a river , please furnish:

1. detailed micro- drainage,

2. Flood passages,

3. Flood periodicity in the area.

3.9. Does the proposed project involve construction on any sandy stretch?

Yes ☐ No ☐

If yes, please furnish details

Height (above MSL in metres)

3.9. Does the project involve extraction of sand, levelling or digging of sandy stretches within 500 metres of high tide line?

Yes ☐ No ☐

If yes, mention the activity involved and area.

1. Stretch

2. Area (sq. metre)

3.10 Does the project involve any dredging?

Yes ☐ No ☐

3.11 Whether there will be any change in the drainage pattern after the proposed activity?

Yes ☐ No ☐

If yes, what are the changes?

A. What is the maximum extent?

B. Is any additional area to be flooded?

## 4. Raw material Required During Construction:

| S.No. | Item | Quantity (Tonnes) | Mode of Transport | Source |
|---|---|---|---|---|
| 1 | Blue metal | | | |
| 2 | Bricks | | | |
| 3 | Sand | | | |
| 4 | Cement | | | |
| 5 | Bitumen | | | |
| 6 | Diesel | | | |
| 7 | Others (Please specify) | | | |

## 5. Water Required During Construction:

5.1 Water Requirement (cu.m / day)

| S.No | Purpose | Average Demand | Peak Demand | Source | Type treated/ Untreated/Fresh/ Recycled | Remarks |
|---|---|---|---|---|---|---|
| 1 | Airport Development | | | | | |
| 2 | Dust Suppression | | | | | |
| 3 | Drinking | | | | | |
| 4 | Others (please Specify) | | | | | |
| | Total | | | | | |

5.2. Source of Raw Water Supply (Net)

| S.No | Source | Cum/hr | Cum/day |
|---|---|---|---|
| 1 | Sea | | |
| 2 | River | | |
| 3 | Ground Water | | |
| 4 | Rainwater Harvesting | | |
| 5 | Municipal Water Supply | | |
| 6 | Others | | |

### 5.3. Solid Waste:

A. Solid waste generated during Airport development (Tonnes / day)

1. Top Soil
2. Overburden
3. Others (please specify)

Total:

### 6. Storage of inflammable / hazardous / toxic substances) :

| S.No | Name | Consumption (in TPD) | Maximum Quantity at any point of time(tonnes) | Means of transportation |
|---|---|---|---|---|
| 1 | Bitumen | | | |
| 2 | Diesel | | | |
| 3 | Others (please specify) | | | |

### 7. Landscape:

A. Total area of project ( in ha)

B. Area already afforested ( for existing projects), in ha

C. Area proposed to be afforested (in ha )

D. Width of green belt (minimum, in m.) along with alignment

E. Trees planted and proposed

NOs

1. Planted
2. Proposed
3. List of species

## 8. Rehabilitation & Resettlement Plan including vocational training and other avenues of employment:

A. Population to be displaced:

| S.No. | Name of Village | Population | Land outsets only / Homestead | Land+ Home stead | Oustees only |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

B. Rehabilitation Plan for Oustees.

C. Site where the people are proposed to be resettled

D. Compensation package

E. Agency / Authority responsible for their resettlement

## 9.0 Environmental Management Plan

a. Details of Pollution Control Systems:

| | Existing | Proposed |
|---|---|---|
| Air | | |
| Water | | |
| Noise | | |
| Solid Waste | | |

b. Expenditure on environmental measures:

| S. No | | Capital cost | | Annual recurring cost | |
|---|---|---|---|---|---|
| | | Existing | Proposed | Existing | Proposed |
| 1 | Pollution control (provide break-up separately) | | | | |
| 2 | Pollution monitoring (provide break-up separately) | | | | |
| 3 | Fire fighting & emergency handling | | | | |
| 4 | Green Belt | | | | |
| 5 | Training in the area of environment & occupational health | | | | |
| 6 | Others (specify) | | | | |

c. Details of organizational set up/cell for environmental management and monitoring:

| |
|---|
| |

d. Details of community welfare/peripheral development programmes envisaged/being undertaken by the project proponent:

| |
|---|
| |

## 10. Compliance with environmental safeguards (for existing units)

a. Status of the compliance of conditions of Environmental Clearance issued by MoEF, if any enclosed — Yes ☐ No ☐

b. Status of compliance of 'Consent to Operate' issued by SPCB, if any, enclosed — Yes ☐ No ☐

c. Latest 'Environmental Statement' enclosed — Yes ☐ No ☐

## 11. Public Hearing

(a) Date of Advertisement

(b) Newspapers in which the advertisement appeared

(c) Date of public hearing (DD/MM/YYYY)

(d) Public Hearing Panel chaired by & members present

(e) No. of people attended the public hearing meeting and number of people from the lease area.

(f) Summary/details of public hearing in tabular form.

| Issues raised by the Public | Response/Commitment of Project Proponents | Suggestions made by the Public Hearing Panel |
|---|---|---|
| | | |

Date .....

Name and Signature of the Competent Officer/Authority
E-mail:
Phone and Fax nos:

Given under the seal of organization on behalf of whom the applicant is signing

**Note:**

The project authorities are earnestly advised in their own interest to provide complete information on points, which they think are relevant to their proposal. Non supply of required information may result in considerable delay in according environmental clearance.

All correspondence with MoEF shall be made by the authorized signatory only. The authorized signatory should also submit a document in support of his claim of being an authorized signatory for the specific project (refer notification No. SO. 3067 (E) dated 1st December 2009)